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MEDICAL JURISPRUDENCE

AND

TOXICOLOGY

REESE

TEXT-BOOK

OF

MEDICAL JURISPRUDENCE

AND

TOXICOLOGY

BY

JOHN J. REESE, M. D.

LATE PROFESSOR OF MEDICAL JURISPRUDENCE AND TOXICOLOGY IN THE UNIVERSITY OF PENNSYLVANIA; LATE PRESIDENT OF THE MEDICAL JURISPRUDENCE SOCIETY OF PHILADELPHIA

FIFTH EDITION

REVISED BY

HENRY LEFFMANN, A. M., M. D., PH. D.

PROFESSOR OF CHEMISTRY AND TOXICOLOGY IN THE WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA; PATHOLOGICAL CHEMIST TO THE JEFFERSON COLLEGE HOSPITAL, PHILADELPHIA.

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PREFACE TO FIFTH EDITION.

SINCE the publication of the fourth edition of this work a large amount of material relating to medical jurisprudence and toxicology has been published, including several large treatises and many articles in standard periodicals. It will be found, however, that very little has been added to the general principles of the subject; the new matter has been largely reports of peculiar or difficult cases. In fact, medical jurisprudence partakes strongly of the conservative spirit that law always shows. It would be unsafe to accept every new principle as a guide. New methods of research arise from time to time; more careful applications of old methods enable errors to be corrected; but much experience is needed before any material change can be made in generally accepted doctrines. The most notable advance in methods of research made since the last edition of the work is the application of the *x*-ray, and it seems that this method will be of great value in medical jurisprudence.

There is a rapid and constant increase in the volume of laws relating to the status of the medical profession, to the conduct of medical education, and to sanitary questions;

but these involve almost entirely questions for lawyers alone, and need not be considered here.

In the work of revision for the present edition the purpose of the book has been kept in view. It is not a laboratory manual, nor is it intended as a comprehensive work for experts; but it is a students' text-book and a reference work for general practitioners in medicine and law. On the publication of the first edition it attained immediate popularity, and has held its place ever since. Its distinguished author had an unusually wide experience as an expert, as well as a teacher of the subject, and brought, therefore, to the preparation of the work an extended knowledge of facts and a high capacity for expressing them in clear and correct language.

H. L.

715 WALNUT STREET, PHILADELPHIA, *March, 1898.*

ABSTRACT FROM PREFACE TO FIRST EDITION.

THIS Text-Book has been written more particularly to meet the wants of students of Legal Medicine. The author is aware that the field has already been occupied by able and popular treatises on Medical Jurisprudence, well known to the professions of Medicine and Law; but an experience of over twenty years as a public teacher of this branch of science has convinced him that students in both these professions who desire to acquire a knowledge of Medical Jurisprudence are too often deterred from their purpose by being confronted by the ponderous works of recognized masters, extending to three, and even six, large octavo volumes.

To avoid the above objection, the author of the present work has endeavored to condense into a handy volume all the *essentials* of the science, and to present the various topics in a simple and familiar style, giving greater prominence, of course, to those of the greatest practical importance.

The author has not hesitated to avail himself freely of the materials so abundantly presented in the elaborate and

classic works of Casper, Taylor, Beck, Wharton and Stillé, Tidy, Guy, Tardieu, and others, always desiring to give due credit to the authority quoted, and usually doing so at the time; and he would embrace this opportunity to express his obligations to these authorities. He is sincerely desirous to encourage an increasing interest in the students of both Medicine and Law for that most important, but too much neglected, subject—Forensic Medicine; and he would indulge the hope that the present treatise, in its unpretentious size and style, may aid in so doing.

PHILADELPHIA.

CONTENTS.

CHAPTER V.

Personal Identity.

CHAPTER VI.

Causes Producing Violent Death.

Examination of Blood Stains.

Burns and Scalds.

Death from Different Forms of Apnea (Asphyxia).

CHAPTER X.

Infanticide.

CHAPTER XI.

Legitimacy—Inheritance.

CHAPTER XII.

Rape.

CHAPTER XIII.

Insanity.

PAGE

CHAPTER XIV.

Malpractice.

CHAPTER XV.

Life Insurance.

CHAPTER XVI.

Toxicology.—(Death from Poisoning.)

CORROSIVE IRRITANTS.

Mineral Acids.

Alkalies and their Salts.

IRRITANTS PROPER.

Arsenic.

Antimony Compounds (Tartar Emetic).

Mercury Compounds (Corrosive Sublimate).

PAGE

Lead Compounds.

Copper Compounds.

Zinc, Bismuth, Tin, Iron, and Chromium Compounds.

Vegetable and Animal Irritants.

Animal Irritants.

NEUROTIC POISONS.

Cerebral Neurotics.—(1) Narcotics.

TEXT-BOOK

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TOXICOLOGY.

CHAPTER I.

Medical Jurisprudence, Legal or Forensic Medicine, may be defined to be the science which applies the knowledge of Medicine to the requirements of Law. In the discovery of truth, the great purpose of Law, every department of human knowledge should be made to assist. Cases affecting life, reputation, or property, and requiring for elucidation an appeal to medical knowledge, are termed medico-legal cases, and the science of the application of medicine to them is named Medical Jurisprudence.

The students of Medicine and Law are equally interested in a knowledge of this science, and it should require no argument to show its importance to members of these professions. The former cannot entirely evade its claims, although he may seek to do so, since the very nature of his profession, together with his assumed public position as an accredited physician, render him liable at any moment to

be confronted with a case involving the intricate questions of homicidal, suicidal, or accidental death; of infanticide; of criminal abortion; of rape; of drowning; and of numerous other cases which must necessarily depend for their elucidation upon the physician who had previously given his professional attendance in the case, and who must give his evidence before the court. He may be placed under circumstances in which he may be compelled to give, publicly, a professional opinion; he then necessarily assumes the functions of the "legal physician"; and whether qualified or not must now do his best, in the position of a medical witness, to aid the cause of justice. How important, then, that the practitioner of medicine, even though he may have no special leaning toward legal medicine, should become acquainted at least with the general principles and leading facts of the science!

With very few exceptions, Medical Jurisprudence is but superficially taught in the medical colleges of this country. In some it is made a necessary or compulsory qualification for the student's graduation. In some States of the Union, the importance of a knowledge of this branch of science is officially declared by refusal to recognize the diploma of any medical school which does not teach it as an integral part of its curriculum, and by refusing to license any physician to practise who cannot give satisfactory evidence of a knowledge of this science.

Numerous cases brought before a court can only be settled by an appeal to medical knowledge; sometimes it is to one department of medicine, and sometimes to another; and it not infrequently happens that several branches of medical science may be simultaneously called into requisition in order to aid in arriving at a proper decision.

It is more particularly when the physician appears upon the witness stand, and assumes the functions of the *medical witness*, that medico-legal knowledge is of the most importance. After he has accomplished the investigation of some case by carefully conducted methods of scientific research, there remains the duty of giving the results of his investigations to the court in the form of *evidence;* and to be prepared to do this in the proper manner constitutes one of the chief acquirements of the medical jurist. This will be more manifest as we detail the mode of proceeding in a criminal case.

The Coroner's Inquest.—The first public duty usually imposed upon the physician who has been in attendance, or has investigated a case of violent death, is to testify at the coroner's inquest. In many civilized countries, especially English-speaking communities, a special officer, the *coroner*, is appointed to investigate the unknown or unexplained causes of sudden death. For example, a body is discovered with or without marks of external violence, or dragged out of the river; the body of a new-born child has been found in a well or cesspool, or floating in the water; a person is discovered dead at some hotel, far distant from his home; or a person in apparent health suddenly drops dead in the street. In these and in analogous cases the law provides for an investigation to ascertain the cause and circumstances of the death; and, if due to violence, then the nature of it—*i. e.*, whether from a wound (gunshot or otherwise), from a bludgeon, an axe, hammer, or other blunt weapon; or whether occasioned by a fall. In the absence of all external marks of violence, then, might the death not have been produced by poison? In each one of these cases a further

question must be solved—was the death homicidal, suicidal, or accidental ?

The coroner's jury consists of a few men (the number varies in different places), mostly selected from the district in which the inquest is held. Their duty consists in (1) viewing the body and establishing its identity and (2) in holding the inquest, which is a sort of petty court, wherein inquiry is made as to the cause of death, and (in case of homicide) to ascertain, if possible, the guilty person. Witnesses are examined, and the person who has performed the post-mortem examination makes a report and gives his opinion as to the cause of death. The jury consult and render a verdict, which is usually in accordance with the report of the medical officer. In some cases, particularly in cities, where the coroner has one or more specially appointed physicians, it is not considered necessary that the jury should personally *view* the body; it is regarded as sufficient if the body has been identified by the examining physician, and the autopsy reported.

The special duty of the coroner's inquest is to discover the *cause of death;* it does not fall within his province to discover the individual who caused it. Nevertheless, it often happens that, in the course of the investigation, suspicion may so strongly point to some one as to warrant the coroner committing the suspect to prison to await further investigation. The usual verdict in cases of violent death (shown to have been neither suicidal nor accidental) is that of murder or manslaughter, against some person or persons, known or unknown.

The office of coroner, as at present constituted in many places, exhibits antiquated and inconvenient methods. In Massachusetts the office has been abolished, the investiga-

tion of sudden or suspicious deaths being carried out by physicians, called "Medical Examiners," who do not refer evidence to a special jury, but can place any suspected criminal in the charge of the courts.

The post-mortem examination is an inseparable part of the coroner's inquiry in a case of this character, and constitutes its most important factor. It should be performed carefully and thoroughly. No one is fit to undertake it but a skilled anatomist and pathologist. The autopsy should be performed deliberately, and by daylight if possible. Since the most serious issues may be at stake, the utmost caution should be exercised in conducting the autopsy. It will always be an advantage if the examination be performed by two experts.

In giving his evidence before the coroner's jury, the medical man must not undervalue the importance of the situation; he must not forget that the testimony is generally recorded, and that it will surely confront him at any subsequent trial. This fact should impress upon him the seriousness of the occasion, and remind him of the importance of drawing up his report with due care and accuracy.

The Criminal Court.—After the coroner's inquest, the case, if a criminal one, is, in most communities, sent to a grand jury, who institute a preliminary examination and determine if a *prima facie* case is made out. This hearing is usually a matter of routine, and a "true bill" is found. The case next comes regularly for trial. To this trial the medical witness is summoned to appear by a subpœna, which he must obey. He will undergo a strict and severe examination as to his opinions and observations on the case. He will be cross-examined as to his professional knowledge and acquirements, the extent of his opportunities for

making such investigations as the one pending, the accuracy of his post-mortem or toxicologic examination, and other matters which may annoy and confuse him to no small degree, unless he be prepared beforehand by medico-legal knowledge and training. A witness properly fortified need have no fear for himself; for, as he goes upon the stand honestly to testify to the truth, "he need only," to quote the language of the late Dr. Taylor, "bear in mind two considerations: first, that he should be thoroughly prepared on all points of the subject on which he is to give evidence; and, secondly, that his demeanor should be that of an educated gentleman, and suited to the serious occasion on which he appears."

In regard to medical evidence several points require brief notice. After opening the case before the court, the prosecuting attorney calls witnesses and examines them "according to the rules of evidence"; this is technically called the *examination in chief*. The *cross-examination* follows; this is conducted by the counsel for the defense, and may be aimed at contradicting and overthrowing, if possible, the previous testimony. A counsel for the defense is allowed very considerable latitude in the cross-examination of the witness, and it will be necessary for the witness to exercise considerable self-control, since it is only in this way that a brow-beating attorney can be parried. The witness must also remember that there are technical methods in the law which are not comprehended by laymen, and it is especially advisable that if objection be made by either attorney to any question, the witness should pause until the matter is decided by the judge. It is inadvisable for a witness to appeal to the judge for protection against a line of questions. An honest and properly informed phy-

sician has nothing to fear from a lawyer. *Re-examination* sometimes follows the cross-examination of the witness, when it becomes necessary to clear up or explain any matter that may have been obscured by the cross-examination.

After the examination of the witnesses called by the prosecuting officers, that of the witnesses for the defense follows, and the same general line of examination is pursued. When expert witnesses for the defense are called, a most unpleasant exhibition frequently takes place, one expert directly contradicting another on the opposite side. Such professional tilting is sometimes sneeringly designated as the "war of the experts," and is certainly deeply to be regretted, as it tends greatly to prejudice both the court and the public against expert testimony in general.

It is well to understand the difference between an ordinary and an expert witness. The former testifies only to facts which he has seen, or heard, or learned from personal observation. The "expert" or skilled witness does not necessarily testify to facts, but gives his opinion on facts observed by himself or testified to by others. An expert witness is supposed to be specially skilled in the matter on which he is to testify. It is just here that much difficulty arises in cases involving expert evidence. The so-called "experts" are often selected with the intention that they shall advocate particular views or belittle in every possible way the ability or work of the experts on the opposite side.

The expert witness has his rights as well as his duties and responsibilities. One of these rights is his compensation. It has often been made a subject of just complaint that an

expert witness is placed upon the stand and his professional opinions, which may be of the utmost value in the pending case, extorted from him piecemeal by the questionings of counsel, and yet he receives as his compensation merely the pay of an ordinary witness. Some legal authorities admit that the expert is not bound to submit to this imposition, and that he is entitled to a special fee for his services. The English courts have not yet definitely settled this matter. The late Dr. C. Meymott Tidy used the following pointed language concerning this matter: "No witness can be compelled to give his opinion in the witness box. Further, no one is bound to accept a subpœna merely to state opinions. The witness that can speak to any actual fact connected with the case must attend the trial if required to do so; but the expert, however wide his experience, cannot be forced to give the court the value of his general or special knowledge." There can be no question as to the propriety and justice of this position; but in this country the practice of the courts in relation to the compensation of medical experts is by no means settled. In the great majority of our States the law allows no additional compensation to the expert, and it is not an infrequent practice to subpœna him as an ordinary witness, and when in the witness box to use him as an expert. What shall the expert do in such a case? How shall he conduct himself consistently with his own dignity and proper rights? Certainly, the court would not use a man's private property—the work of his hands, his skilled manual labor, or the product of his farm or merchandise—without adequate compensation; why, then, should they exact from him that which is the result of the labor of his brain, than which nothing can be more exclusively and definitely a man's own

private property? It is to be regretted that so few of our American courts and legislatures have appeared to recognize the true bearings of this subject, so that with us the old practice still prevails of affording no legal protection to the medical expert in the matter of fees.

It rarely happens in important criminal cases, especially in poison cases, that either the prosecution or the defense would venture to trust their interests to a *reluctant* witness; and certainly he would be a reluctant witness who had been dragged perhaps hundreds of miles from his home and business by a subpœna which the law forces him to obey, and who, after spending, it may be, days in attendance upon the court, is compelled to give, for the paltry pittance of the wages of a day-laborer, that which has cost him years of labor and study to acquire, in the shape of an opinion, on which may turn the question of life or death to the prisoner. In all such cases the ordinary practice is to arrange beforehand with the expert for his proper fee, and the witness should be admonished to look carefully about his interests in this matter. Let him remember that the district attorney, who usually directs the affair, may have no authority to pay the fee; neither does this authority always lie with the court. The responsible parties in the case are often the county commissioners, or some equivalent county authority. With these alone ought the expert to make his arrangements, and always previously to undertaking the case; and to these alone can he look, legally, for his fee.

As regards the obligation of a witness to obey a subpœna when he is to be questioned only as to his opinion, the mandate of the court in this country is obligatory; the witness's duty is to obey it, and then, if not previously,

endeavor to arrange about his compensation before giving his evidence.

The subject of expert testimony has engaged the attention of some of the ablest minds in both the professions of law and medicine, but with no very definite results. No doubt, our present system of volunteer medical experts is open to objections, which, under our present laws, cannot be remedied. A system is much advocated of each State appointing one or more experts, who shall be State officers, physicians of thorough education and experience and training in this particular line, who shall devote their time and attention exclusively to this duty, and for which they shall receive an adequate compensation. Such an office, properly filled, and kept aloof from all political considerations, might be of real benefit ; but it would not, necessarily, abolish the unseemly contention of the experts in the court room, for in the United States the clause in the Constitution providing that in every criminal trial the accused shall have the power to call witnesses in his favor and be confronted by the witnesses against him will permit of the same contentions between experts that now occur. Moreover, it is not likely that in our present political system a satisfactory selection of "State experts" will be made. Social as well as political influences will operate to control such appointments, and the former as well as the latter are capable of promoting unfit persons. The system of State experts is in vogue in some countries in continental Europe ; but the method of criminal procedure is different in such places, and does not exhibit the care of the rights of the accused which is the principle of English jurisprudence.

There are a few practical rules relating to the giving of

evidence which it is well the medical expert should observe. He should prepare himself thoroughly upon all the points bearing on the case in which he is called to give evidence. This he should do in order to further the ends of justice, and also to avoid personal censure. He should be accurate as to weights, measures, distances, size, relationship of objects, etc., never guessing, but testifying with certainty and precision.

He should maintain a quiet, dignified, and composed demeanor on the stand, not exhibiting any irritability of temper, however much he may feel provoked by the rudeness of the opposing counsel. He should beware of any display of arrogance or assumption of manner, or of stubbornness or testiness of behavior, which are sure to make him appear to disadvantage in the court room.

The witness should give his answers in a clear and audible tone, and these replies, together with his explanations, should always be given in the simplest possible language; and they should be free from all ambiguity, otherwise they will require explanation, which is apt rather to weaken the testimony. It will be better, also, for him to avoid all voluntary remarks, and confine himself closely to answering the questions put to him.

He should never be afraid frankly to confess his ignorance. Nothing is more dangerous than for a witness to attempt to guess, for fear of being thought ignorant.

He should particularly avoid the use of all technical expressions and learned formulæ in giving his descriptions. Pomposity and pedantry should, of course, be avoided by every sensible and well-bred witness, since they are certain to expose him to ridicule and contempt.

Dying Declarations.—By this term is understood such declarations as are made by a dying person, who believes that he is in actual danger of death, and that his recovery is impossible. Such declarations are received in evidence without being sworn to. The law presumes that declarations made at so solemn a crisis as at a dying moment must be sincere. They may not, however, necessarily be true, although sincere—*i. e.*, believed in, at the time, by the deceased. Dr. Taylor quotes an instance of a dying woman in St. Thomas' Hospital who accused a man of assaulting her. He was found guilty and executed. A year after the execution his innocence was established, the real murderers having been discovered. These declarations, moreover, must relate to the actual circumstances of the death, and to nothing else.

A magistrate or other official authorized to take deposition in important cases, if such can be had, is the proper person to take down dying declarations, the physician in attendance merely giving opinion as to the hopelessness of the case and the soundness of the person's mind. In the absence of an official, the medical man is the best substitute, and he should content himself by simply writing down the exact words of the dying person, without adding his own interpretation of them. If possible, the dying person should sign the declaration after having it read over.

CHAPTER II.

PHENOMENA AND SIGNS OF DEATH.

AMONG the numerous and diversified cases claiming medico-legal attention, perhaps the most frequent are those of violent death. A knowledge of the *Signs of Death* becomes of the utmost importance, since cases not infrequently present themselves in which there is considerable doubt and uncertainty as to the reality of the death.

For a proper comprehension of this subject, attention should first be directed to the distinction between *molecular* and *somatic* death. By the former term is to be understood the incessant disintegration of tissue which is going on in the body during the active processes of life; the waste of material thus produced being compensated by the reparation. In youth, the supply is in excess of the waste, and growth is the result; in advanced age, the reverse is the case. *Somatic* death is the cessation of all the vital functions of the body, or the death of the whole body. The latter is the popular idea of death, and the time when it takes place is generally recognizable. The precise period when universal *molecular* death occurs cannot be accurately determined. No doubt, molecular life may continue some time after somatic death, as is evidenced by post-mortem temperature and muscular irritability, by the post-mortem beating of the heart, and by certain acts of nutrition and secretion.

Although the outlets of human life are so numerous and varied, and the phenomena of death are diversified, the

immediate or *actual* cause must in every instance be referred to an arrest of the function of one or other of the three great centres of life—the heart, the lungs, and the brain. And so intimately are the functions of these three "centres" connected together, that when one ceases to act, the actions of the others speedily cease. Each one of these three varieties has its own special phenomena or signs; and each exhibits its own peculiar or characteristic post-mortem appearances. The following is Bichat's classification: (1) death beginning at the brain, (2) death beginning at the heart, and (3) death beginning at the lungs.

I. Death Beginning at the Brain—Coma.—*Symptoms.*—Stupor, more or less profound; insensibility to external impressions; loss of consciousness; breathing slow, stertorous, and irregular; respiration gradually failing, and ceases as the medulla oblongata begins to be affected. The chest ceases to expand; the blood is no longer aerated; the pulmonary circulation is arrested; the lungs cease to act, and finally the heart's pulsations are brought to a stop.

Post-mortem Appearances.—(1) Effusion of blood or serum in the brain or cavities, caused by (*a*) apoplexy, (*b*) rupture of vessels from injury or fracture of the skull, or in disease of the arteries, under excitement. (2) Pressure caused by (*a*) embolism, (*b*) abscess, tumor, or other organic disturbance; (*c*) congestion of the vessels of the brain. (3) Concussion from a blow or fall.

II. Death Beginning at the Heart—Syncope.—The heart may cease to act from two distinct causes: (1) from a deficiency in the *quantity* of blood—its normal stimulant

(*anemia*); and (2) from a defect in the *quality* of the blood, or from a loss of heart power (*asthenia*).

Anemia is produced by sudden loss of blood in disease, as in rupture of an aneurism; uterine and other hemorrhage; or by violence, as from wounds of heart and large vessels, causing fatal hemorrhage.

Symptoms.—Paleness of face; lividity of lips; vertigo; cold sweat; slow, weak, and fluttering pulse; gradual insensibility. There may also be nausea and vomiting, hallucinations, delirium, jactitations, irregular breathing, sighing, and convulsions before death. The nervous symptoms are due to want of brain power, in consequence of a deficient supply of blood.

Post-mortem Appearances.—Heart contracted and empty (if inspected early). If life has been protracted for several hours, a heart clot may be found. General paleness of the organs and tissues.

Asthenia.—Here, the cause of the cessation of the heart's action is either a defect in the quality of the blood or some disorder of the organ producing a loss of heart power: (1) by disease, as (*a*) various cardiac disorders, such as fatty degeneration, diseases of the valves, etc.; (*b*) all exhausting diseases, as phthisis, cholera, cancer, etc.; (2) starvation; (3) certain injuries, as blows on epigastrium; (4) certain poisons. Cases of heart failure are popularly termed *paralysis of the heart.*

Symptoms.—Coldness of hands and feet; lividity of lips, fingers, toes, nose, and ears; extreme muscular weakness; feeble pulse; senses and intellect not affected, but preserved to the last. This latter is well seen in the collapse of Asiatic cholera.

Post-mortem Appearances.—The heart not contracted; its

cavities contain more or less blood, or else are dilated and flabby. Blood in all large vessels, but no congestion of lungs or brain.

III. Death Beginning in the Lungs—Apnea—(Asphyxia).—Respiration may be arrested (1) by any mechanical impediment to the ingress of air into the lungs, as (*a*) pressure of the thorax; (*b*) tetanic spasm of the muscles of respiration; (*c*) paralysis of the pneumogastric or phrenic nerves; (*d*) exhaustion of muscular power; (*e*) foreign bodies in the air passages; (*f*) compression of the throat; (*g*) suffocation; (*h*) drowning. (2) By disease, as pneumonia, phthisis, etc., spasm of the glottis, edema of the glottis, pharyngeal abscess, embolism of the pulmonary artery, and the accumulation of serum, blood, or pus in the pleural cavities. (Strictly speaking, most of these diseases cause death through mechanical interference with breathing.)

Symptoms.—Great dyspnea, lividity of the face, loss of consciousness, vertigo, and occasionally convulsions.

Post-mortem Appearances.—The right side of the heart and the whole venous system are usually filled with dark blood; the left side, together with the arteries, is generally empty. Cases are, however, reported where the right cavities of the heart were found empty. The lungs themselves are nearly always gorged with dark blood; but there are some exceptions to this, which will be noticed hereafter.

By keeping in mind the foregoing varieties of somatic death, together with the characteristic post-mortem appearances attendant on each, the examiner will be considerably aided in arriving at a definite conclusion as to the real cause of death in any particular case.

In every inquest over a dead body *five* important questions will present themselves for solution: 1. The reality of the death. 2. The cause of the death. 3. Was the death instantaneous, sudden, or was the death agony prolonged? 4. The time that has elapsed since the death. 5. In the case of the body of a new-born infant—Was it born alive?

The first of these questions comprises *the phenomena and signs of death.* How can we distinguish a case of real from one of apparent death? In the great majority of instances, of course, there is no practical difficulty; but exceptional cases do, at times, present themselves in persons recently dead, where the corpse still retains so much the appearance of life as to occasion some doubts about the reality of dissolution. The natural horror of being buried alive also suggests the most scrupulous caution in the matter, although we rarely, if ever, hear of cases of premature burial in civilized countries; yet instances are not wanting to show that such may have actually occurred in places where a fatal pestilence has prevailed to such a degree as to produce a panic and demoralize the community. Dr. Tidy reports that Nussbaum states "that he believes many to have been buried during the war (Franco-German) that were not really dead, but merely suffering from an extreme lethargy arising from loss of blood, exhaustion, hunger, cold, and fear."

The following may be regarded as the **Signs of Death**; but no single sign should be relied upon exclusively:

I. The Complete and Continuous Cessation of the Functions of Circulation and Respiration.—In some cases of apparent death—syncope, trance, catalepsy—these

two functions seem to be suspended for a time; but the suspension is apparent, not absolute. The absence of the pulse at the wrist is no criterion of the suspension of the circulation, as this may be going on so feebly as only to be detected by a very close stethoscopic examination of the heart, which should never be omitted in cases of doubt. The condition of both the circulation and respiration, in such cases of apparent death, simply resembles that of certain animals in the state of hibernation. Thus, M. Bouchut informs us that in the marmot the heart beats during its state of activity amount to 80 or 90 a minute, but are reduced to 8 or 9 very feeble pulsations during the period of hibernation. Instances are recorded (like that of Colonel Townshend, by Dr. Cheyne) of a voluntary suspension of the heart's action; but as these cases occurred many years ago, before the discovery of auscultation, it is, we think, highly probable that the suspension was not absolute, but only reduced down to so fine a point as to have escaped notice. It is certainly contrary to all scientific reasoning that life can continue many minutes without the circulation of the blood; therefore we need have no hesitation as to the reality of death, if we can be positively certain of the continuous arrest of this function, say for one hour. The converse of this proposition, however, is not always true; that is, the pulsation of the heart may continue for a brief time after actual death. Duval mentions having seen the heart of a criminal beat fifteen times after decapitation, the left auricle pulsating for an hour. This is corroborated by some observations made in Paris upon the body of a decapitated criminal. This same phenomenon, as is well known, is witnessed still more remarkably in the heart of the stur-

geon, frog, and snapping turtle, which will continue to pulsate many hours after removal from the body. This fact, as also the post-mortem contraction of the muscles under galvanic stimulus, proves the continuance of molecular life after somatic death.

This question of the beating of the heart in a still-born infant being regarded as a valid sign of life, will be discussed later.

The same remarks may be made with regard to the function of respiration. The *absolute* and *continuous* cessation of breathing—say one hour—may be regarded as a positive sign of death. In cases of apparent death, as already remarked, this function may apparently be suspended; but it is in reality only reduced down to its minimum of action. This likewise should be verified by careful and repeated auscultation. The common practice of holding a feather near the nose or mouth may serve, by its movements, to indicate breathing. So likewise the deposit of moisture on a mirror, held in the same position, will indicate the feeblest respiration. But neither of these is an absolutely positive sign, since they both fail when applied in the case of the hibernating animal which we know is really alive.

Another method is to place a small vessel containing mercury on the thorax of the body lying face upward; the slightest respiratory action will be indicated by the movements of a reflected image, made to fall on the surface of the bright metal.

It may be remarked that in cases of trance, catalepsy, and other instances of suspended animation, the body never exhibits either the pallor or coldness of real death. Moreover, if a ligature be applied around the finger of a corpse,

no change of color will be observed; but if the experiment be made on a living body, the tip of the finger will become of a red or purple color, in consequence of the arrest of the capillary circulation at that spot. A ligature around the wrist will cause swelling of the dorsal veins of the hand if there is any life (B. W. Richardson). The most powerful counter-irritants, *e. g.*, oil of mustard, cantharides, etc., will produce no redness or blisters on the dead body.

II. The Condition of the Eyes.—The changes produced in the eyes by death are: (1) The entire loss of sensibility to light; the pupils neither contract nor expand under this stimulus. This, however, is not a positive sign, since the same insensibility to light is witnessed during life in certain cerebral affections, and is also the result of the action of certain poisons. (2) The action of atropin and other mydriatics to expand the pupil, and of calabar bean (eserin) to contract it during life, is lost within a few hours after death. These agents do, however, produce a visible effect if applied very soon after the cessation of life, and before the body has become cold, and all muscular irritability has ceased. (3) The cornea loses its transparency, and the eye-ball its elasticity, very speedily after dissolution. But these conditions may likewise exist before death, as the results of disease. In apparent death, the cornea retains its translucency; the papilla of the retina is of a rose-red color; and the fundus of the eye is furrowed by the arteries and veins of the retina. At the moment of death, the papilla of the optic nerve becomes quite pale, and the central artery of the retina disappears. It should also be remarked that the eye sometimes retains its lustre after death. This is seen after poisoning by hydrogen cyanid and carbon dioxid.

III. The Pallor of the Body.—This sign is very uniform, though not without some exceptions, as in the case of persons of very florid complexions, and in exceptional instances where the cheeks and lips retain their rosy color for some days after death, so as to occasion some uncertainty as to the actual fact of death, in the minds of relatives. It is also wanting in cases of death from yellow fever and jaundice; moreover, the red, inflammatory zones around ulcers and burns, tattoo marks, the spots of purpura, and ecchymoses or bruises do not disappear after death. It must also not be forgotten that a death-like pallor is seen in cases of swooning, and sometimes in the cold stage of ague, and in collapse.

IV. Loss of Animal Heat.—During life, the animal body possesses the wonderful faculty of maintaining its own normal temperature (about 98° F.) independently of the surrounding medium. This is effected as the result of certain vital processes. At the moment of death there is a slight rise in temperature; but a decline begins soon and continues until the body acquires the temperature of the surrounding medium, precisely as any other warm body parts with its excess of heat to the surrounding medium. It never gets lower than this medium, unless the temperature of the latter becomes suddenly increased; then, for a while, the body will be really cooler than the temperature of the atmosphere. The sense of touch does not convey an accurate idea of the actual coldness of the dead body, since the conducting power of the tissues varies materially. The direct application of the thermometer to the body is the only safe method. If the temperature in the mouth is

lower than the surrounding atmosphere, it is a strong presumptive sign of death (Richardson).

The time in which the cooling of the body is completed is stated to be, on the average, from fifteen to twenty-four hours. Prof. Casper makes it from eight to twelve hours. It varies considerably, according to the condition of the body itself, according to the medium in which it is kept after death, and also according to the manner of death. Fat bodies retain heat longer than lean ones ; the bodies of young children and of old persons cool more rapidly than those of adults ; while the bodies of those who die from suffocation, electric shocks, and from certain diseases, *e. g.*, yellow fever and tetanus, retain heat longer than others.

The body, of course, cools more rapidly if exposed to the air unclothed than if covered up in the bed-clothes ; also in a large airy apartment, than in a small, close room. It will cool more rapidly in water than in the air. In death from chronic wasting diseases, and also in cholera, the body cools very rapidly. According to Taylor, loss of blood does not hasten the cooling process.

The interior of the body retains its heat considerably longer than the surface, so that if an autopsy be made within twenty-four hours after death, even when its exterior feels perfectly cold, the abdominal viscera may exhibit a temperature twenty degrees, or more, higher than that of the surface.

It should not be forgotten that coldness of the body is a frequent phenomenon of sickness ; it is witnessed in hysteria and ague, also in cholera. Its value as a sign of death consists in the fact that it is progressive and continuous, while the coldness of disease is sudden and not permanent. Hence the degree of coldness of the body

will often be a good indication of the time that has elapsed since death.

Another fact to be noticed is that the rate of cooling after death, although progressive, is not uniform; it is much more rapid during the earlier hours than later. Dr. Goodhart's observations show that during the first three hours after death the loss of heat per hour amounted, in the robust, to 3.5°, in the emaciated, to 4.7°; while when the body was nearly cold, the loss per hour was, in the emaciated, 1.12°, and in the robust, 1.26°.

A marked and prolonged rise of temperature after death is observed in some cases. This exceptional condition occurs occasionally in the bodies of those who have died from yellow fever, cholera, tetanus, smallpox, and some other acute disorders. The exact cause of this singular rise of temperature (*post-mortem caloricity*) is not clearly understood. In some instances the increase of heat has amounted to 9° F. Dr. Davy records a post-mortem temperature of 113° F. in the pericardium. We may suppose that in these cases molecular life has continued after the cessation of somatic life. We know that muscular irritability and contractility continue for many hours (under certain conditions) after death, and this undoubtedly indicates the continuance of their molecular activity up to a certain point.

The injection of a few drops of solution of ammonium hydroxid hypodermically leaves no mark in actual death, but occasions a dark spot in apparent death.

V. Cadaveric Rigidity, or **Rigor Mortis.**—By this is understood the stiffening of the body so generally observed after death. It usually occurs simultaneously with the cooling process. It may be stated to be universal in death

from any cause, and to be present in the lower animals as well as in man. In some instances, however, it is so transient as to escape notice. It comes on at very variable periods, from a few moments to eighteen to twenty hours after death. This remarkable variation in its approach is chiefly due to the condition of the muscular system at the time of death. Its duration is equally variable, lasting from a few moments to many hours, or even weeks. After the rigidity passes off the body regains its original pliancy, and decomposition immediately commences. As a general rule, the putrefaction of the body is retarded until the rigor mortis has passed off.

It commences usually in the muscles of the eye, which often become rigid within a few minutes after death; next in the muscles of the neck and lower jaw; then in the chest and upper extremities; afterward in the muscles of the abdomen and lower limbs. The rigidity generally passes off in the same order; thus, the legs frequently remain quite rigid after the upper portion of the body has regained its suppleness.

The seat of the rigor mortis is undoubtedly the muscular system. That it is in no wise dependent upon the nervous system is proved by the fact that all the nerves supplying a muscle may be divided, and yet the muscle will continue to act, contracting under the galvanic stimulus. But response ceases immediately on division of the muscle. Even the removal of the brain and spinal marrow has no effect in preventing the muscular contraction. Again, the muscles of a paralyzed limb become equally rigid with those in sound health. The cause of the contraction is usually ascribed to the coagulation of the muscular plasma, a proteid principle possessing the property of coagulation to

a high degree. The reaction of a muscle in rigor mortis is acid (reddens blue litmus); but it becomes alkaline after the rigidity passes off. While in the state of rigor mortis, the muscle is opaque; before this, it is partially translucent. Brown-Séquard has shown that a current of arterial blood will restore muscular contractility to a rigid limb.

The duration of rigor mortis is one of its most important features. As already observed, this is extremely variable, although, as a rule, it does not set in until the body has begun to cool; still, in some of the lower animals, and notably in birds, it often manifests itself while the body is yet warm. From the observations of Brown-Séquard and others it appears that the period after death when the rigor mortis manifests itself, together with its duration, is dependent chiefly, if not altogether, upon the previous degree of muscular exhaustion. To properly understand this, it should be remembered that immediately after death the muscles are in a state of complete relaxation, giving to the body perfect pliancy. This condition may last for so brief a space of time as not to be noticed, though usually it continues for three or four hours, after which rigidity commences. During this period of relaxation the muscles have not yet lost their molecular life, so that they will respond to galvanic and other stimuli. Hence, although the contraction of a muscle by electricity is no positive sign of somatic life, still it will enable us to conclude either that the person is yet alive or, more probably, that death has very recently occurred. The cessation of all muscular contractility under galvanic stimulus is a proof not only of the death of the individual, but it also indicates that the death was not very recent—hardly within three or four hours.

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So long as the muscles retain their contractility, the rigor mortis is postponed.

It can now be understood that whatever produces exhaustion of the muscular system must thereby hasten the approach of cadaveric rigidity. Thus, in death from exhausting diseases, as in phthisis, or after protracted convulsions, or when the muscular system becomes exhausted by over-exertion and fatigue, as is seen in over-driven cattle, or in animals hunted in the chase, the rigor mortis shows itself early, and lasts but a short time; whereas, if death occurs suddenly, in a previously healthy person, the rigidity is postponed for many hours, but when once established it continues for a much longer period. Thus, according to Brown-Séquard, the bodies of decapitated healthy criminals were observed not to become rigid until after the lapse of ten to twelve hours, and the rigidity lasted over a week, even in warm weather. An experiment of the above-named physiologist very satisfactorily proves this statement. Three dogs of equal size were poisoned with strychnin in different doses. One took two grains, and died almost immediately. The second took half a grain, and died in twelve minutes. The third took one-fourth of a grain, and died, after protracted convulsions, in twenty-one minutes. In the first animal, whose muscular system had been least exhausted by the spasms, rigor mortis did not set in before the lapse of eight hours, and the duration was nineteen to twenty days. In the second, where the muscular exhaustion was greater, the rigidity appeared after two and a half hours, and lasted five days. In the third, in which the muscular exhaustion was the most protracted, the rigor mortis was developed as early as thirty minutes, and lasted less than a day.

It has been supposed by some that the rigor mortis does not occur in the bodies of persons killed by lightning; experience shows this to be a mistake. It is also stated to be absent in those killed by snake-poison, in whom likewise the blood remains fluid. Neither is it interfered with by the previous loss of blood by hemorrhage. It is, however, dependent on temperature, at least so far as regards the duration, which is shortened by heat and prolonged by cold. Bodies submerged in cold water retain their rigidity for a considerable length of time.

When a joint or articulation stiffened by complete rigor mortis is forcibly bent, the rigidity is destroyed. If, however, the rigidity is incomplete, it will be resumed afterward. This may serve to distinguish real death from certain cases of catalepsy, tetanus, and hysteria, accompanied by rigidity. In all these latter cases the stiffness will return on removal of the opposing force.

Cadaveric rigidity is not so strong as voluntary muscular contraction. As a rule the flexors are more affected than the extensors, so that the limbs are generally found to be slightly bent after death.

The fact that the involuntary muscles are likewise subject to rigor mortis should not be lost sight of, as it might lead to an error as to the true pathological state of an organ, on making an autopsy. The heart, for instance, may be found very firmly contracted after death by rigor mortis; this might be mistaken, by the inexperienced, for a true contraction of the organ, the result of previous disease.

Closely connected with rigor mortis, if not indeed a modification of this very state, is the condition described as cadaveric spasm. This is exhibited in the bodies of persons who have died by sudden and violent deaths, in whom there

seems to be present a powerful will-power just prior to the death, and producing strong muscular contraction at the moment of dissolution. This spasmodic contraction, more-over, appears to pass at once, after death, into the usual rigor mortis. The best illustrations of this peculiar condition are afforded in those cases of determined suicides who have taken their lives by shooting themselves with a pistol. Very commonly, in such cases, the weapon is found so tightly grasped in the dead hand that considerable force is required to remove it. The same condition is sometimes witnessed in the bodies of drowned persons; fragments of wood, grass and weeds, or other objects which had been convulsively seized in the water before death, being found tightly grasped in the hands; and where two persons have perished together by drowning, it is not uncommon to find them, after death, convulsively clasped in each other's arms. To a similar reason, doubtless, is to be ascribed the singular and striking postures sometimes exhibited by the bodies of soldiers killed in battle. Thus, the attitude of one is described as "resting on one knee, with the arms extended, in the act of taking aim; the brow compressed, the lips clenched—the very expression of firing at an enemy stamped upon his face, and fixed there by death. A ball had struck this man in the neck. Another was lying on his back, with the same expression, with his arms raised in a similar attitude, the minnie musket still grasped in his hands, undischarged" (Taylor).

VI. Cadaveric Lividity, or Suggillation.—This term is applied to those livid or violet-colored patches or discolorations which are observed upon the body at variable

periods after death, usually after several hours. It is the result of the settling of the blood in the capillaries by gravitation. Hence, it is noticed in the most dependent parts of the body, such as (supposing it to be lying on the back) the back, under surface of the neck, calves of the legs, and under portions of the thighs. These patches, at first isolated, gradually increase in size and coalesce, so as to cover a large surface of the body. Cadaveric lividity is an unquestionable "sign" of death. It makes its appearance sometimes much earlier than at others; and for this variation no very satisfactory reason can be assigned.

The most important point connected with cadaveric lividity is not to confound it with ecchymosis or bruising, to which it bears a considerable resemblance. Several cases are recorded where a body has been found covered with these death-spots, and the mistake has been made of supposing them to be bruises, and consequently attributing the death to violence inflicted during life. The medical examiner should be particularly cautious not to confound them. Fortunately, a very simple test will settle the question. If the scalpel be drawn through a suggillation, no blood will flow; the most that will be observed will be a few bloody points or specks, arising from the division of small veins of the skin. If, however, the patch be ecchymosis (where the effused blood has been infiltrated into the cellular tissue), the incision will either be followed by a flow of blood or else a coagulum will be seen. Moreover, while the ecchymosis is sometimes raised above the level of the surrounding skin, the cadaveric stain never is. The change of color following an ecchymosis—from purple to green and yellow—will also serve as a ground of distinction. These cadaveric spots are not affected by age,

sex, or constitution, and they follow upon all kinds of death, not excepting that caused by hemorrhage.

Suggillation takes place in the internal organs as well as upon the surface of the body, producing in the former appearances strongly resembling true congestion and inflammation, for which they are, without doubt, frequently mistaken by the inexperienced; and as it may be a matter of considerable consequence in a post-mortem examination not to confound these two conditions, the examiner should be very cautious as to his pathological inferences. These internal suggillations are also termed hypostatic congestions; they appear chiefly in the lungs, brain, kidneys, and intestines. The fact that they invariably occur in the most dependent portions of these organs should be suggestive of their true origin, since a real congestion or inflammation exhibits itself either throughout the whole organ or else upon its upper surface equally with the lower one; certainly it is not confined exclusively to the under portion, as is the suggillation. The observer should be careful not to be misled by finding suggillation on the upper part of an organ, as it may have been that the body has been recently turned over. When it occurs in the intestines, it may readily be distinguished from true inflammation by simply lifting up several folds of the bowels, when the horizontal line which previously had marked the hypostatic settling of the blood becomes immediately broken and disjointed, whereas, if it had been a real congestion or inflammation, the redness would have involved the whole circumference of the intestines, and there would have been no broken line of separation.

In the brain, hypostatic congestion might be mistaken, by the inexperienced, for one form of apoplexy; and in the

spinal cord, it might be confounded with spinal meningitis. In the heart, true suggillation is not believed to occur ; but this is replaced by the formation of post-mortem clots.

VII. Putrefaction.—This is usually regarded as the most unequivocal "sign" of death. By this term is understood those spontaneous chemical changes undergone by all dead animal bodies resulting in the elimination of fetid gases. The period after death when putrefaction first manifests itself varies considerably, being dependent upon several conditions, some of which are connected with the body itself and others extraneous to the body.

Among the conditions inherent to the body itself are :

1. *Corpulence.*—Flat and flabby bodies undergo putrefaction more speedily than thin and lean ones, doubtless on account of the preponderance of fluids in the former.

2. *Age and Sex.*—For the same reason, the bodies of new-born children and of women dying in child-bed (according to Casper) decompose more rapidly than others, especially the aged.

3. *The Manner of Death.*—The bodies of persons dying of diseases in which the vitality of the blood has been impaired, as in typhus fever, pyemia, etc., undergo rapid putrefaction ; also after death from certain poisons, and especially gases, illuminating gas, and hydrogen sulphid ; also from suffocation from smoke, and, indeed, from suffocation generally. Putrefaction is also accelerated in bodies that have been much bruised and mangled by machinery, or by railway and other accidents ; but we must except those cases where the body remains protected from atmospheric influences, as when buried beneath ruins, etc. On the other hand, the process is retarded in death by alcohol,

phosphorus, sulphuric acid, arsenical compounds, and some narcotic poisons. The antiseptic properties of alcohol and arsenic are well understood. The action of acids is a direct retarding influence on the development of the microbes causing putrefaction. Admitting all the above conditions, and giving them due allowance, there are doubtless other causes, as yet unknown to us, which influence the rapidity of putrefaction. Casper adduces the instances of four men about the same age and general physique, and all killed at the same time in a riot. They were buried at the same time, and in precisely similar coffins and graves; yet on subsequent examination, the extent of decomposition was found to be very different in the different bodies.

The external conditions influencing putrefaction are air, moisture, and temperature. These conditions act by reason of their influence on the development of microbes to which putrefaction is due. Most microbes require oxygen for growth and multiplication; all require heat and moisture. The processes for preserving perishable articles, such as meats and fruits, illustrate these principles. The influence of air is not limited to the mere supply of oxygen; but it modifies putrefaction according to the amount of moisture it contains. For this reason perfectly dry air, such as that of the arid deserts of Arabia and Africa, by its rapid desiccating properties, arrests putrefaction, the body speedily losing its fluids by evaporation and shriveling up into a sort of mummy. The effects of an entire exclusion of air in retarding the process of decomposition in a human body are witnessed in the burial of royal personages in leaden coffins hermetically sealed, and these afterward enclosed in marble sarcophagi. When these have been opened, hundreds of years subsequently, the remains have been found

preserved. On the other hand, bodies naked, or but slightly clothed, and buried in pine coffins, which soon decay, and in shallow graves to which the air has easy access, will undergo very speedy decomposition. The nature of the soil and the depth of the grave also materially influence this process. Thus, a loose, sandy soil and a shallow grave favor it by the ready admission of air, while soil of a stiff, clayey nature and a deep grave would retard it, for the opposite reason. From recent observations, it has been ascertained that part of the atmospheric influence upon decomposition is the presence of the micro-organisms, termed bacteria or bacilli, which float in such myriads in the air, and which find their peculiar habitat in dead animal matter.

The different tissues and organs of the body undergo decomposition in proportion to the amount of fluids they contain. In this respect the brain of the young infant and the eye contrast widely with the bones and teeth. The human body contains about eighty per cent. of fluids; hence its great tendency to putrefy after death. The bodies of drowned persons undergo rapid decomposition, unless the water be extremely cold, or contains substances with antiseptic properties which prevent the growth of microbes. Bodies thrown into dung-heaps and cesspools speedily putrefy. If a body be completely deprived of its fluids by drying, putrefaction is arrested, as has been noted.

The influence of *temperature* as an agent in putrefaction is very manifest. The temperature most favorable to this process is that between 70° and 100° F. It commences, however, as low as 50°; but it is completely arrested at 32°, below which the body becomes frozen, and also at 212°, at which point all micro-organisms are killed. An

animal body may be preserved for an indefinite period if completely frozen in snow or ice. It is recorded that the body of a Russian nobleman that had been buried in the frozen soil of Siberia, on being exhumed after a period of ninety-two years, was found in a state of almost perfect preservation.

The effect of temperature in the process of putrefaction is familiarly shown in the influence of the seasons. In summer a body will decompose very much sooner than in winter—a circumstance that should not be forgotten when giving an opinion respecting the date of death in an unknown case. According to Casper, the relative rapidity of decomposition in bodies exposed to the air, kept in cold water, and buried in the earth, is in the ratio of one, two, and eight ; that is, putrefaction advances as rapidly in one week in the open air as in two weeks in the water and in eight weeks in the earth (average).

Dr. König, of Hermannstadt, has reported on the appearance of a number of bodies of Hungarians taken from a deep pool of the waters of the Echoschacht after the lapse of forty years. They were in a state of perfect preservation, without a trace of decomposition or of the formation of adipocere. The internal organs were of the consistence of those of a newly-deceased corpse, and the brain was hard, as if preserved in spirit. In the interior of these bodies a large amount of sodium chlorid was found, crystallized in cubes, deposited on the organs, and which had evidently penetrated into the bodies from without. These crystals were found even within the perfectly closed pericardium and adhering to the heart.

It may here be remarked that a body floating near the top of the water will decompose more rapidly than when at

the bottom ; and when taken out of the water and exposed to the air, the putrefaction will be far more rapid than if left in the water.

External Signs of Putrefaction.—The following is the order generally observed, externally, in the progress of putrefaction of bodies exposed to the open air. In from one to three days in summer (three to six in winter), there appears a greenish or yellowish-green spot upon the abdomen, three or four inches in diameter, accompanied with the peculiar odor of putrefaction. The eyeball becomes soft and yielding within the same period. In a few days more this greenish discoloration has spread generally over the whole body—first in spots, which subsequently gradually coalesce. Dirty red streaks now show themselves throughout the surface, marking the course of the blood vessels. In ten or fifteen days (in warm weather) the epidermis begins to loosen, forming blebs or blisters containing fluid. Gases now begin to form in the chest and abdomen, causing these cavities to swell out greatly. The eyeballs protrude from the same cause ; the face is swollen ; the features are so much bloated as to be no longer recognizable. In two or three weeks the blebs of the cuticle may have burst open ; maggots appear ; the formation of gases increases, so that the body is enormously swollen. If it be now punctured, the gas which is emitted will frequently take fire on the approach of a flame (hydrocarbons). Other gases are likewise formed, the result of animal decomposition, as carbonic acid, hydrogen sulphid, hydrogen phosphid, nitrogen, and amin. The nails now loosen ; and in the further progress of putrefaction the cavities burst open and discharge their contents ; the softened flesh dissolves off from the bones, which now become exposed, and ultimately fall

apart from the skeleton. The sexes cease to be distinguishable, except perhaps by the discovery of a uterus, which appears to be almost the last organ to yield to putrefaction.

The foregoing description is only a general and average one, since the process of the external putrefaction of the body is variable, and is influenced by many circumstances, some of which are not yet fully understood.

Internal Signs of Putrefaction.—The order in which the internal organs of the body undergo decomposition being more regular as to time, affords a rather better criterion as to the period of death. The first organ of the body that shows signs of decomposition after death is the lining membrane of the windpipe (larynx and trachea); this assumes a dirty red coloration simultaneously with the appearance of the greenish spot upon the abdomen. That this is not the result of injection of the blood vessels is proved by the microscope. In the earliest stage of death this membrane is always very pale, except when the death has been caused by laryngitis or suffocation. The examiner should be cautioned not to mistake this mark of putrefaction for congestion. Very soon after this stage of redness it becomes of an olive-green color, the rings of the trachea separate, and it falls to pieces and disappears.

The next (2) organ to decompose is the brain of young infants. The reason of this lies, of course, in the fact that this organ at such an early age is so very delicate and is so little protected by its bony covering from the outer air. When decomposing, it changes into a soft, rosy, pulpaceous mass, and flows out of the smallest openings.

Then follows (3) the stomach. This organ is among the earliest to putrefy after death. The decomposition first

manifests itself in discolorations of the fundus, together with the formation of dirty red spots or streaks in the posterior portion of the organ, owing to hypostatic congestion. These spots soon ramify, and cover the whole lining membrane. There is great risk of mistaking these spots for signs of congestion or inflammation due to irritant poisoning. The examiner should be specially cautious on this point, as it is often impossible to distinguish them apart by a merely ocular inspection. It is quite certain that a post-mortem redness of the mucous membrane of the stomach cannot, of itself, prove a case of poisoning. In the further progress of putrefaction the stomach softens, the spots become greenish and gray, then black, with dark red streaks (veins) running through them. It is finally converted into a pulpaceous mass, and ceases to be recognized.

Next to the stomach the intestines (4) follow in the process of decomposition. They become discolored, very much as in the case of the stomach; then they become distended with gas, burst, and discharge their contents.

The spleen (5) comes next in the order of putrefaction. If not diseased at the time of death, it may retain its integrity for two or three weeks. It first assumes a dark red color, then a greenish-blue, then becomes soft and pulpy, so that its substance can be rubbed down with the handle of the scalpel.

Following the spleen, the omentum and mesentery (6) are the organs next to decay. If there is not much fat connected with them, they will rapidly dry up and disappear.

The liver (7) resists putrefaction for a considerable time after death—in adults for several weeks. In infants it decomposes earlier. It first becomes of a green color, then black; then softens, shrivels, and finally disappears. In

case of death by arsenical poisoning the liver might resist decomposition for a considerable time.

The brain of adults (8) does not begin to show signs of putrefaction until the end of the fourth or fifth week, and sometimes even later. The process is usually most marked at the base, which softens and becomes bluish-green, and gradually progresses upward and then inward. If the brain has been injured, as by a depressed bone, or by a gunshot wound, it is affected earlier.

Next in order is the heart (9). This is one of the toughest of all the organs. The softening here begins in the columnæ carneæ, and progresses toward the walls of the organ, which finally deliquesce into an unrecognizable mass.

It is remarkable that the lungs (10), which are very soft organs, and are so nearly connected with the outward air, should resist putrefaction so long. These organs are often found quite sound for weeks, provided they were healthy and uninjured at death. The first evidence of their decomposition is the formation of little bladders of air in the sulci, between the lobes, on the under surface, looking like a string of beads. These increase rapidly, the lung structure turning first green, then black, and finally softening and disappearing.

The kidneys (11) follow the lungs. They become reddish-brown and soften, then assume a greenish-black color, and disappear. Next in order (12) follow the bladder and esophagus; next (13) the pancreas, which, though a soft organ and located near the stomach, is among the last to decompose. Then follow (14) the diaphragm and the arteries,—the tissue of the latter persisting when everything around it has fallen into a shapeless mass.

Last of all, according to Casper, is the uterus (15), which has been found to retain its identity at the end of seven months after death. This fact is of great medico-legal importance where the question arises of the possibility of pregnancy.

This description of the progress of putrefaction, both external and internal, of the human body is taken chiefly from Casper. It is intended to represent the average, both as regards appearance and time. As already stated, there may be considerable deviations from the order laid down, depending upon circumstances. Modern embalming has reached such a stage of perfection as to delay putrefaction indefinitely. Embalmed bodies have been exhumed after two years' burial and evidences of injury proven to the entire satisfaction of an accident insurance company, at whose instance the examination was made.

Saponification, or Adipocere.—It sometimes happens that the process of putrefaction is interfered with under peculiar circumstances, and gives place to a condition known as the saponification of the body. This was first observed by Fourcroy, who discovered, during the removal of human remains from one of the public cemeteries of Paris, that a number of the bodies, instead of undergoing ordinary putrefaction, had been converted into a new substance, which he styled adipocere.

This adipocere has an unctuous feel, somewhat like spermaceti, and is of a dirty white color. Chevreul found it to be an ammonium soap—principally ammonium oleate and stearate. The ammonium is derived from the nitrogen of the tissues. The presence of water seems to be essential

to this change. It only occurs in bodies that have been buried in wet or very moist soil, and never in those in a loose or sandy soil. Frequently, when a grave fills with water, the contained body is converted into adipocere. The same thing may take place in bodies which remain in the water for a certain time.

The composition of adipocere is not always precisely the same. It is usually an ammonium soap, but may contain calcium—the latter condition existing especially when the body has been immersed in water containing notable amounts of calcium salts. This was determined experimentally by Orfila, who placed an ammonium adipocere in a solution of calcium sulphate; he found that after a time it had been changed into calcium oleo-stearate. Adipocere is insoluble in water, but partially soluble in alcohol. It emits a greasy smell in burning. Its odor resembles somewhat that of musty cheese.

From the fact that if a body remain immersed in the water for any length of time it is likely to be changed into adipocere, it becomes an important medico-legal question to establish the period necessary for this conversion. Devergie ascertained that the body of a new-born child was more or less changed into adipocere after remaining in the water for five or six weeks. We see at once the value of this knowledge, since bodies of new-born infants are frequently thrown into wells, privies, and cesspools. If a body be found under such circumstances, with the process of saponification only just begun, it is probable that it could not have been long in the water, and *vice versâ*. According to the same authority, an adult body requires an immersion in water for one year before the conversion is completed, and when it is buried in wet earth, a period of

three years may elapse before the change is completely effected.

Mummification.—This constitutes another process by which the ordinary putrefaction of the body is interfered with. By mummification we understand the complete dessication or drying up of the body. It results either from burial in the arid and sandy soil of hot countries, such as Arabia and Egypt, or from exposure of the body to a constantly cold and dry atmosphere—where, for instance, it is placed in a vault through which a constant stream of dry, cold air is pouring. Such a condition of things is found at the Hospice of St. Bernard, in Switzerland. In the charnel house attached to this establishment the bodies of those who have perished in the snows are placed. The atmosphere is so constantly cold and dry that the flesh and fat completely dry up.

It is quite impossible, from the mere inspection of a mummy, to venture an opinion as to the length of time that has elapsed since death. Many Egyptian mummies are several thousand years old.

Certain agents retard, and others promote, decomposition. The former comprise the various antiseptics. Lime, although popularly supposed to hasten putrefaction, in reality retards it, as is shown by a simple experiment of Dr. John Davy, who buried a piece of raw flesh that had been first covered over with powdered lime. It continued sound much longer than another piece that was buried without the lime. No doubt the lime here partly operated by excluding the atmospheric air. The strong acids and alkalies, although they do not hasten putrefaction, produce chemic changes, and in this way aid in the removal of a body.

The period and method of interment materially influence the rapidity of putrefaction. If decomposition has set in *before* burial, the action will progress far more rapidly than in a body which was interred before putrefaction had begun. The depth of the grave and nature of the soil also exercise a marked influence. The cause of death may influence the rapidity of the decomposition of the body.

Having disposed of the first question—Is the death real or apparent?—we may consider the second: How long a time has elapsed since the death? It sometimes becomes of extreme consequence to determine this in connection with the attempt to prove an alibi on the part of the prisoner. This matter is to be determined, in the absence of direct evidence, solely by attending to the different "signs" or phenomena of death, already described. The inferences may be drawn, first, from the signs occurring before putrefaction; secondly, from those occurring after it.

1. *Inferences From the Signs Exhibited before Putrefaction.*—If the body is only slightly cold, and rigidity is just commencing about the jaws, the eyes glazed, and the eyeballs sunken, death has occurred, most probably, from a quarter of an hour to four or five hours previously. The inference can never be more than approximative for the reasons already given.

Suppose the body to be perfectly cold (externally) and rigid throughout: it has probably been dead from twelve or fifteen hours, to three or four days. If rigidity is complete over the body, and cadaveric lividity (suggillation) is manifested over the surface, death has probably occurred one to four days previously.

The importance of attending to the above phenomena is

shown by a case mentioned by Taylor. A man was convicted and transported for killing his wife. The woman was discovered, at 8 o'clock in the morning, with her throat cut. She was very rigid throughout the upper part of her body, and the whole body was cold. The prisoner was able to prove an alibi between the hours of 4 and 8 A. M., and his counsel endeavored to show that the post-mortem coldness and the partial rigidity might have developed within four hours, which, if true, would have exculpated the accused. This point was overruled by a mass of medical testimony to the contrary.

2. *Inferences after Putrefaction.*—Suppose the body exhibits the greenish discoloration on the abdomen and the peculiar odor of putrefaction exists; the rigor mortis has passed off, leaving the body cold, but pliant: death has probably occurred one to three days previously, in summer, and three to six or eight days, in winter.

If the greenish-yellow discoloration extends more or less over the whole surface, together with greenish-brown stains, and dark red lines over various parts, along with relaxation of the sphincter ani muscle, it must have been dead from eight to ten days, in summer, and from ten to twenty days, in winter.

If blebs are found over the skin, and some of them opened, with maggots in the muscles; if the body is green all over, and the chest and abdomen are enormously distended; the nails loose, or falling out; the color of the eyes not recognizable; the features very much swollen—then the death must have occurred two to three weeks previously, in summer, or four to five weeks, in winter.

If the chest and abdomen have burst open and discharged their contents, and some of the bones are denuded

of their fleshy coverings; the eyes enormously swollen; the body has been dead, probably, from two to four months.

The above "inferences," it must be remembered, are only approximative. They cannot be positive under any circumstances; and, moreover, they are predicated on the supposition that the body under examination has not been buried, but exposed to the action of the atmosphere. Great care must be taken not to give a very positive opinion on this question, as the inferences are to a great extent conjectural, and dependent on many contingencies.

Some definition of winter and summer should be given—*e. g.*, over 60 for summer, and below this for winter.

Attempts have been made recently by some French observers to determine what time has elapsed since the interment of a body, by the succession of various species of animal life developing in and about the tissues, and some interesting results have been obtained. Such data, however, will need to be verified for each district, season, and kind of soil before being of any practical value.

CHAPTER III.

MEDICO-LEGAL INVESTIGATIONS—THE POST-MORTEM.

THE physician who undertakes the examination in a medico-legal case, including a post-mortem, assumes a serious responsibility. He must be fully prepared to meet the various contingencies that may present themselves, and he should execute his work thoroughly and with strict impartiality. The examiner should be an expert anatomist and pathologist, and a close and careful observer.

In all cases where dispute is likely to arise, it is advisable to have two examiners, and any suspected person should be allowed representation by some one of his own selection. It will be proper, however, to secure the consent of the coroner, public prosecutor, or other officer for representatives of suspected or interested parties to be present. As a general rule such opportunities are not solicited by attorneys representing clients accused of crime. The examination should be made by daylight, since artificial light conceals shades of color which it is important to recognize, such as stains by nitric acid. Analytic and microscopic investigations are needed in many cases, and great care should be taken to place all organs which are to be examined for poison in separate clean jars. Many physicians will thoughtlessly place several abdominal viscera, such as liver, kidney, and stomach, in one jar; but this is highly objectionable, since it deprives the chemist of all opportunity to determine if the poison has been absorbed during life, a most important point. If examinations are to

be made for blood stains, on the clothing of the body or on any surrounding objects, these should be marked, wrapped up, and preferably removed from the room or immediate vicinity of the body before the post-mortem is begun, thereby avoiding the suspicion that the objects had become blood-stained during the post-mortem, which would destroy the value of any evidence adduced by future examination.

The examination should be exhaustive, so that the examiner may be able to testify with some positiveness as to the cause of death. For example, the discovery of a disease of the heart sufficient to cause death should not preclude an examination of the lungs and brain, in either of which the real cause of the death may be found. Poison in the stomach may co-exist with a ruptured aneurism, a clot in the brain, or a diseased heart. The examination, moreover, should be conducted methodically, and all the details recorded.

The post-mortem ought to be made on the first day subsequent to the death, but it should never be declined on account of the interval that may have elapsed, nor even if the body be in a state of putrefaction.

The *surroundings* should first claim attention, such as the *locality* at which the body was discovered, as this may afford a clue, especially in the case of infanticide, when, for example, the body of the infant is found in a privy-well or dung-heap. Sometimes the body will have been dragged by the murderer to a distant spot ; or the victim may have followed his assailant a short distance after receiving the blow. *Footmarks* should be noted, together with their direction ; *evidences of struggling*, as denoted by the condition of the grass, dust, or mud in the road, and disturbed or broken condition of

bushes, which also may be bespattered with blood ; the finding of a weapon or missile. Marks of bloody fingers or blood tracks from bloody shoes should be sought for before any blood is drawn by the post-mortem examination. If there be no wound or evidence of bleeding having occurred from the body under examination, the presence of blood on the hands or any part of the clothing or body would suggest that his assailant had received a wound. If in a room, the position of the body in reference to articles of furniture, to any weapon, to glasses, cups, bottles, etc., from which poison may have been taken. It is also advisable to make a rough drawing of the locality.

As regards the body itself, the examiner should note its exact position when found : this is especially important if death was caused by a wound. The clothes should be carefully examined to determine whether torn or cut, and whether any torn fragment corresponds with the garment of the accused, or of the deceased ; whether marked by blood-stains, or by an acid ; if stabbed, whether the cuts correspond with the wounds on the body. The clothes should be removed, and the body minutely inspected. It should also be identified, if possible. Notes should be made of the sex, height, weight, age, and general development ; of scars and other marks ; abnormalities ; blood, seminal, and other stains ; the color of the skin and condition of the eyes and teeth ; the temperature and rigidity of the body ; the degree of putrefaction ; lividity and ecchymoses ; matters flowing from the nose, mouth, and ears—blood from or in either of these orifices is often indicative of fracture of the skull ; state of the tongue ; expression of the countenance. The hands should be inspected, to ascertain if they hold a weapon—whether loosely or tightly grasped ; or if portions of hair or clothing

are firmly held (denoting a struggle), and whether these articles correspond with those found on the prisoner; whether stained with blood or blackened by powder (the latter indicating firearms). The presence or absence of foreign bodies in the nose, mouth, anus, and vagina should also be noticed.

All wounds should be carefully examined as to depth, extent, and direction, and whether they suit the weapon that may be supposed to have occasioned them; the condition of their edges, as indicating whether recent or not; marks of inflammation, suppuration, or gangrene; whether any foreign body be present, as a ball, fragments of clothing, etc. The scalpel may be used, if necessary, to enlarge the wound, with care not to interfere with its original character. If there is contusion without solution of continuity, the examiner should not fail to look for internal injuries.

In *fractures* and *luxations*, notice their condition and that of the surrounding parts. In cases of *burns*, observe their degree and extent; whether merely inflamed or vesicated, and the state of the adjacent parts.

In *females*, examine the genital organs, especially in case of alleged rape, pregnancy, and recent delivery.

In *new-born children*, ascertain their length and weight, their color, sex, diameters of head, the condition of the lungs, hair, nails, membrana pupillaris, genital organs, and condition of the umbilical cord. The question of a live-birth will be treated more fully in a later part of this work.

The modern methods of photography permit valuable pictures to be taken, so as to preserve accurate evidence of the surroundings and position of a body. It is scarcely necessary to refer to the uses that X-ray methods may subserve in medico-legal work.

The Internal Examination of the Body.—It is important that the examination should be thorough and systematic, and in order to secure this it will be necessary to follow a definite course under all circumstances, or to be able to supply a sufficient reason for a deviation in any particular case. If the investigator be in the habit of always examining the head last, he will be astonished at the amount of blood which will escape if the head be examined first, and thus, by varying his usual course, may mislead himself, attributing the increased flow to abnormal conditions when they are not present. The following order is commended as offering the best advantages with the fewest variations. It is assumed that the external examination has been completed :

The Abdomen.—An incision is made from the interclavicular notch to the pubes, passing to the left of the navel in order to preserve the ligament, and, in the newborn, the vessels which pass to the liver. The incision is carried entirely through the abdominal wall, care being taken not to wound the viscera ; the integument is then dissected from the chest wall as far back as the costal cartilages of both sides ; by forcibly stretching both sides of this incision, an abundance of room will be supplied without any transverse incisions, except in rare cases ; in stripping the chest wall care must be used to avoid the smallest opening of the thoracic cavity, as any contained fluids—blood, for example—may escape, or entering air may change the position of the diaphragm, which it may be important to observe. The abdominal cavity is now to be examined, noting the organs in detail. Note the fluid present ; is it clear or cloudy ; amount ; search for evidence of peritonitis, extravasation of blood or the contents

of the stomach, intestine, gall bladder, or urinary bladder, the finding of which will indicate that there has been a wound or rupture of some of the viscera. If such be found it must be closed, and the cavity carefully cleansed and dried before the chest is opened, as the foreign material in the belly cavity would immediately flow into the chest and complicate the examination of the thoracic viscera. The height of the diaphragm is to be noted (especially in new-born children, where question of still-birth is likely to arise) before the chest is opened, as immediately after no inference can be drawn, as the position of the diaphragm after the chest has been opened may change. In cases of suspected poisoning the stomach should be ligated at both ends before opening the chest, as the gullet might be accidentally wounded, and the stomach contents thereby permitted to escape. The abdominal viscera are not to be examined until after the chest, as the removal of any organ will drain the blood from the heart, and thereby prevent an accurate examination of that organ.

The Thorax.—The costal cartilages, together with the sterno-clavicular ligaments, should be carefully divided, avoiding the large veins of the neck, the pericardium and its contents; the sternum is now reflected.

Do the lungs immediately collapse, or do they fill the chest cavity to distention? Examine pleuræ for adhesions; note character and quantity of fluid in each pleura separately; remove all fluid from the pleuræ in order to prevent the pericardium from being flooded when opened. Open the pericardium in the axis of the heart, being careful not to wound the heart; this can be best secured by pinching up the sack and transfixing, with the back of the knife toward the heart, and, as soon as an opening is secured,

introducing two fingers into the cavity, and thereby protecting the heart. Note the character and quantity of the pericardial fluid ; note the condition of the heart as to distention of cavities ; see that the great vessels given off from the heart are in the normal relation to that organ ; open the heart in situ ; note in detail the contents of the cavities ; is the blood fluid or in clots ? are the clots white, black, or red ? This is important, as it may establish whether the death was sudden or prolonged. If the right side of the heart contain distinct ante-mortem clots, it is highly improbable that the death could have been sudden, as by drowning. A man was found in the water three months after his disappearance, and it was presumed that he was murdered and thrown into the stream. At the post-mortem evidence was found of ante-mortem injury, and clots were found in the cavities of the heart ; but no note was made of their character, and the plea of accidental drowning, set up by the defense, could not be refuted. Had the medical examiner been able to testify that the clots were undoubtedly ante-mortem, it would have established that the death was considerably slower than could have been the case in drowning. Distinctly ante-mortem clots are positive indications of the death agony not having been instantaneous, and may, for this reason, be of the greatest importance in establishing the exact time at which the injury was received or the poison given. The heart may next be removed by cutting through the vessels at its base, and examined as to its weight, condition of its walls and tissue, and state of its valves. Sometimes a microscopic investigation may be required. The aorta should likewise be examined for atheroma and aneurism.

The lungs may be removed by passing the hand beneath

them (noticing any adhesions), and cutting through the bronchi and vessels at their roots. They should be inspected as to their color, density, etc., as indicating disease; the condition of the bronchial tubes and pulmonary artery (embolism); and the presence of foreign matters in the air passages (in case of drowning or of sudden death). A man in apparent health, while away from home, became suddenly cyanosed and fell unconscious from his seat at the table after eating heartily. Relatives claimed that he was poisoned. A careful examination revealed the presence of an irregular fragment of a potato in each bronchus, completely occluding the entrance of air; and it was afterwards shown that he habitually bolted his food. A cud of tobacco or stump of a cigar might as easily give rise to the same difficulty. If blood has escaped into the thorax it should be removed by a sponge, so as to ascertain the color of the parts. The hydrostatic examination of the lungs in newborn children, in cases of infanticide, will be considered further on.

The ribs should be examined in succession for evidence of fracture or other injury. The esophagus may be cut from its attachments in the neck, stripped from the chest, and left to be removed with the stomach; a ligature, in case of suspected poisoning, should be placed at the cardiac end of the stomach to prevent regurgitation of the gastric contents; the esophagus may be opened down to the ligature, and its interior examined for corrosion or other evidence of poison or injury. The organs of the abdominal cavity are to be next examined—the spleen, kidneys, and bladder. If any urine be present in the bladder, it should be carefully preserved in a chemically clean bottle, that it may be examined for albumin, sugar, or for poisons; in the

latter case some of the alkaloidal poisons (atropin, strychnin, etc.) can be physiologically tested for by injecting some of the suspected urine, hypodermatically, into susceptible animals, or chemically, as will be discussed later. The internal and external genital organs are to be examined next, and, in the female, the uterus especially, for evidences of pregnancy, abortion, or delivery. The liver should be next examined.

The *Stomach* should be examined by first ligating it at the cardiac extremity, and then by applying two ligatures at the pyloric end, and cutting between the latter. Note the general external appearance, and then open it along its lesser curvature. Examine the contents, as to quantity, character and odor, and reaction. Carefully inspect the lining membrane with a lens for solid particles of phosphorus, crystals, or patches of arsenic, or other mineral poisons, fragments of leaves or seeds, or other foreign matters. Note any evidences of inflammation or ulceration. If an analytic examination of the stomach and its contents is to be made, it is better if it can be so arranged not to open the stomach until it is delivered to the chemist. Under ordinary circumstances, except in well-appointed morgues, no facilities are at hand for examining for crystals, fragments of leaves, etc., and hence this had better be deferred until the chemist has access to the organ.

The *Intestines*, after inspection for twist, strangulation, or hernia, should next be examined, by removing them from their attachments, and slitting them throughout with an enterotome; looking for inflammation and ulceration of the glands, and for any foreign matters; also noting the condition of the appendix vermiformis. In cases of poisoning, the stomach and its contents should be preserved for

chemical examination in a separate jar. The intestines also (at least a portion of the small and large bowel, together with the rectum), and portions of the liver, one kidney and the spleen should be kept for a similar purpose. The jars containing the viscera should be securely stoppered and sealed with the private seal of the examiner, with a label affixed, stating the name of the deceased person, the date of death and of the autopsy. They should then be delivered personally, by him, to a responsible party, from whom he should always take a written receipt. The preservation of each organ in a separate and well-cleaned—preferably new—jar is to be especially urged. Toxicologic examinations are often seriously hampered by the fact that stomach, liver, and kidneys have been placed in one large jar. Such a condition prevents determining the antemortem distribution of the poison.

The Head.—After a careful external examination for wounds or injuries, for which purpose the hair may have to be removed, the scalp should be separated by an incision from ear to ear across the vertex, down to the bone; it should then be everted in both directions so as to expose the skull. Search for fractures, and do not mistake irregular sutures for these. Blood along the line of a suture can be wiped off, along the line of a fracture it cannot; gentle tapping on the bare skull may give a "cracked pot" sound in fracture. Notice any unusual thinness of bone; follow out any fracture to its whole extent; observe any extravasation of blood under the scalp.

The skull should now be carefully sawed around, about half an inch above the opening of the ear, the calvaria removed (under no circumstances should the hammer or chisel be used), and the condition of the dura mater no-

ticed. Look for hemorrhage, either extradural or subdural; if the dura has come off with the calvaria, it should be stripped and the inner table of the skull cap closely inspected for any fracture which may or may not show on the outside. This membrane should be carefully cut around with a probe-pointed scissors, and the arachnoid and pia mater closely inspected.

The upper part of the brain can now be examined before removal—as to congestion of its vessels, laceration, or extravasation of blood upon its surface. This latter is often seen on the side opposite to the external injury. The brain is to be carefully removed, by inserting the fingers beneath it, and dividing the medulla oblongata. The base of the skull should be carefully inspected for fractures.

The brain should be examined from above, slicing it horizontally; regarding specially its consistence, color, presence of extravasated blood or serum, of tumors or abscesses, disease of blood vessels, or of the membranes. In opening the skull of very young children a pair of strong scissors may be used instead of a saw.

The *Spinal Column* should be opened through its whole extent, by sawing through on each side of the spinous processes. The cord, together with the dura mater, should then be removed and examined. Note any fracture, dislocation, or contusion.

The *Neck* should be inspected for marks of violence by the fingers (garroting); by a cord (strangling or hanging), and for ecchymoses. Note should be taken as to the condition of the great vessels and nerves. The cavity of the mouth and nose should be examined; also the condition of the larynx, trachea, pharynx, and esophagus.

In case of disinterment of a body the inspectors should

always view it before it is removed from the coffin; at which time, also, it should be properly identified by the friends or relatives of the deceased.

In a medico-legal examination of a body, such as above described, there should always be present either a second inspector or a clerk, to take down the notes as the autopsy progresses. These notes should comprise the appearances presented by the different organs, stating facts, not opinions. The notes should be read over by both examiners, and, if necessary, corrected before sewing up the body. In many cases it will be expected that a report should be drawn up containing opinions of the case. The length and character of this report will depend on circumstances.

CHAPTER IV.

PRESUMPTION OF DEATH, AND OF SURVIVORSHIP.

Presumption of Death.—This question may be raised when a given person is not heard of for a long period. The law, in that event, presumes death, and the administrator or executor may proceed to settle the estate. This question is not often raised in life insurance cases, when the party insured has not been heard of for many years, and the lawful heirs demand the payment of the policy. It must also be considered in cases in which either married person leaves the other and remains continuously away.

The length of time usually regarded by the law as warranting a presumption of death, in any of the above cases, is seven years from the time the person was last heard from; so that in the case of married persons it is not regarded as bigamy if either party should marry again after the expiration of the seven years of continuous absence without communication or information of any kind on the part of the other. In cases of heirship and property, and in some cases of life insurance, it is often not considered necessary to wait the whole seven years, but settlements have been made by the courts or companies in two years.

The presumption of death must depend on general evidence, being a presumption of *fact* to be determined by a jury. There are cases, however, of a special character, where the courts have decided the presumption of death to be sooner or later than the period of seven years, as, *e. g.*, if the individual concerned was in feeble health when last

heard from. This question would involve medical evidence as to the probabilities of life in such a case.

Presumption of Survivorship.—Questions relating to presumption of survivorship are much more frequently discussed in the courts than those pertaining to presumption of death. There is, however, no general law upon the subject, either in this country or Great Britain, every case in which the question is involved being decided according to its individual merits. When two or more persons perish by the same calamity, in the absence of all testimony the courts frequently refuse to assume that one survived the others, but have decided that all perished together. Yet momentous questions may be dependent upon a legal decision of the question of survivorship; as when the parties dying are a father and a son; if the son survive but for a moment, "his wife shall have dower, for the lands descended the instant the father died." So, in the case of a testator and legatee: if the latter die first, the legacy lapses; but if he survive the testator for ever so short a time, his executors can claim. So, again, the husband of a woman possessed of freehold property (not specially settled) has a life interest in her estate, provided she has issue by him, born during the life of the mother, and which survives her even for a moment of time (tenancy by courtesy). The old Roman law upon this subject, upon which are based most of our modern decisions, enacted that when persons of different ages perished in battle, those under puberty were deemed to have died first; but if the son was above the age of puberty, and both died together, the son was presumed to have survived the parent. In the case of husband

and wife, the husband was presumed to be the survivor (Beck).

According to Foderé and Beck, the French law, as contained in the Code Napoléon, is as follows :—

"I. If several persons, naturally heirs of each other, perish by the same event, without the possibility of knowing which died first, the presumption as to survivorship shall be determined by the circumstances of the case ; and in default thereof, by strength of age and sex.

"II. If those who perished together were under fifteen years, the oldest shall be presumed the survivor.

"III. If they were all above sixty years of age, then the youngest shall be presumed the survivor.

"IV. If some were under fifteen, and others above sixty, the former shall be presumed the survivors.

"V. If those who perished together were over the age of fifteen, but under sixty, the males shall be presumed the survivors, where the ages are equal or the difference does not exceed one year.

"VI. If they were of the same sex, that presumption shall be admitted which opens the succession in the order of nature. Of course, the younger shall be considered to have survived the elder."

According to Section IV. in the above Code, no distinction is made between an infant and a man of sixty years ; yet certainly it may fairly be supposed (as remarked by Dr. Tidy) that the latter had a better chance of life than the former. The Prussian law on this question is about identical with the Code Napoléon. These principles are not a part of the law in the United States or England, except in Louisiana, which has adopted many of the principles of the Code Napoléon.

Although our laws are not decisive on questions of presumption of survivorship, but treat them as questions of fact depending wholly on evidence, and, in the absence of all evidence, regarding them as matters incapable of being determined, still, there are matters of importance connected with each case as it presents itself which deserve consideration in influencing the decision. These points may be considered under the following heads :—

(1) *Probabilities Afforded by the Age.*—Between a father and a child under puberty, the English civil law decides the father to be the survivor. Between the ages of fifteen and sixty there is no probability. Between a middle-aged man and one under fifteen or over sixty, the probabilities are in favor of the former. Between one under fifteen and one over sixty, the former is deemed the survivor ; but the same exception might be taken here as in the case of Sect. IV. of the Code Napoléon. Between two under fifteen, the older is considered the survivor. If the question is between a mother and infant, both dying in childbed, without assistance, the presumption of survivorship is in favor of the mother, because the child might be still-born, and also because, if large, its life might be endangered by delay, and it would be more exposed to danger without assistance, such as strangulation by the cord or suffocation in the discharges of the mother.

(2) *Presumption Afforded by the Sex.*—The presumption is in favor of the male, when it is a question of physical strength and courage, as when a man and woman perish together by drowning, or some other casualty. But in particular cases, the question of the respective health of the two persons might have to be considered. When, however, it is a question of passive endurance, especially where

insensibility supervenes, then the presumption is in favor of the female.

(3) The *Cause of Death*, as affording a presumption of survivorship. In death from asphyxia (apnea), as in smothering, or breathing noxious gases, as women require less oxygen than men, the probabilities are in favor of the former, other things being equal. Thus, it is stated that in Paris, in one year, there occurred three hundred and sixty cases of poisoning by charcoal vapors; of this number there were nineteen instances where a man and a woman were exposed together, and of these only three survived, and all were females. Dr. Beck relates the case of a man, wife, and child, who were all asphyxiated while sleeping in a room which was exposed to the vapors of a coal stove. In the morning the man was found dead, the child dying, but the woman recovered.

In *drowning* or *shipwreck*, the question becomes very complicated, having to take into account the age, sex, strength, and opportunity. Thus, men being stronger, more likely to be able to swim, and in case of shipwreck, being more apt to be on deck, and, therefore, in a better position to escape, have the best probabilities for survival; but, on the other hand, the buoyancy of a woman's clothes might support her in the water, and thus save her life, under possible circumstances. In case of two or more persons, all males, equally exposed, a presumption of survivorship can only be entertained by searching for bodily injuries, or other weakening causes, which would necessarily interfere with the individual's exertions to save his life. Here, also, their respective swimming capacities would have to be considered.

If the question be on the survivorship, in the case of

several persons exposed to excessive cold, the amount of clothing, the physical condition, and the immoderate use of alcohol must all be considered before arriving at a conclusion. The probabilities would here be in favor of the strong adult over the very young, or very old person, and of males over females. The debilitating effects of poverty, entailing a bad nutrition, and also of intoxication, as being especially obnoxious to the effects of cold, should not be overlooked. The perishing of drunken persons on a cold winter's night is a familiar occurrence. In relation to the effects of heat it may be remarked that, while the young and old suffer more from cold than adults, they seem able to withstand a greater amount of heat than the latter.

In death by starvation, the general principle that the young require more food than the aged will determine the presumption of survivorship to be in favor of the latter; also for the female, rather than the male. Certain circumstances, however, should here be considered, such as proximity to water, which would aid in sustaining life for some time, even without food.

CHAPTER V.

PERSONAL IDENTITY.

The medico-legal consideration of the subject of **Personal Identity** is much more important than it may appear at first sight. The question is often raised in trials, and it may constitute the chief link in the chain of evidence. Cases of mistaken identity are constantly occurring, and proofs abundant might be adduced to show that innocent persons have frequently been made to suffer judicial penalties, simply through an error of this nature. Should an alleged child, or other claimant, present his claim to an inheritance, he must first establish his identity before taking further steps in the suit. If an individual is assaulted or robbed, he will be required to identify his assailant before he can successfully prosecute him. Again, a person, after many years' absence in foreign climes, returns home to claim his rightful property or title ; but he is so changed as to be unrecognized by his nearest relatives ; he must be able to prove his identity before the courts before his claim can be sustained. In relation to persons found dead,—whether in cases of recent death, where the body has undergone but little change, or years after the decease, where nothing remains but the skeleton,—the question of personal identity acquires the most intense interest, especially in a trial for murder, where it becomes essential to establish the identity of the alleged victim.

The aid of the physician is not so frequently invoked for proving the identity of the living, since this can generally

be established as satisfactorily by friends and neighbors. Still, there may be occasions of unusual complexity in which a professional opinion may become requisite, as, for example, to verify certain deformities, fractures, scars, and other marks about the person, when these constitute the evidences on which the identification may depend.

The subject will be considered under the two divisions of (1) The Identity of the Living, and (2) The Identity of the Dead.

1. The Identity of the Living.—This may usually be established by the direct evidence of witnesses who have known the individual sufficiently long to have a distinct recollection of his personal appearance ; such is the testimony of relatives, friends, and acquaintances. Although among the myriads of the human family it is very rare to find two persons exactly alike in all points, yet remarkable instances do occasionally occur where the personal resemblance is so striking as to baffle even the skill of the detective ; and this resemblance has been made still stronger by the existence of similar marks, cicatrices, or certain peculiarities of structure in both individuals. Some striking illustrations might be given of the extreme difficulty—amounting, at times, to an impossibility—of deciding the question, which also goes to show how easily witnesses may be mistaken in their evidence on this subject. Only two will be here referred to.

In the year 1560, the celebrated case of *Martin Guerre* and *Armand du Tilh* was tried before the Parliament of Toulouse. Martin had been absent from his home for eight years, when the person named du Tilh appeared, and represented himself as the long-absent man. So strong

was the resemblance, that his statement was universally accepted by all of Guerre's family, including his wife, four sisters, and two brothers-in-law, among whom he lived unsuspected for three years. About this time, however, something occurred to excite suspicions as to the true character of the supposed husband and brother, when he was arrested, and brought before the tribunal, on a charge of fraud. Upon his examination he gave satisfactory answers to the most minute questions in relation to Guerre's former life. Some one hundred and fifty witnesses were examined during the investigation, of whom between thirty and forty testified, from a life-long acquaintance, that the prisoner was Martin Guerre; while about the same number swore positively that he was Armand du Tilh, whom they well knew; and over sixty, who knew them both, declared that they were unable to say which the prisoner was. Finally, however, the real Martin appeared upon the scene, when he was immediately recognized. The four sisters who had previously testified that du Tilh was their real brother now admitted their error, and acknowledged the distinction. There being now no doubt of the guilt of the prisoner, he was condemned, and afterward executed.

The other instance is afforded in the recent famous Tichborne case, in which a person named Orton, with various aliases, undertook to personate an English baronet, heir to a large entailed estate. So successful was his scheme that "he was sworn to be Sir Roger Tichborne by eighty-five witnesses, among whom were Sir Roger's mother, the family solicitor, one baronet, six magistrates, one general, three colonels, one major, two captains, thirty-two non-commissioned officers and privates of the army, four clergymen, seven tenants of the Tichborne estates, and seventeen

servants of the family." The claimant also gave proof of "a fish-hook wound on the eye, of a mark of bleeding on the ankle, and of a peculiar scar on the head," all of which the genuine Sir Roger possessed. The case, however, broke down on cross-examination, many circumstances being proved against the claimant, which need not be here enumerated. Suffice it to say that a verdict was taken against him, and that an indictment was found against him for perjury.

Now, as a fair inference from the above two instances and other remarkable cases, we may assume that appearances are not conclusive evidences of personal identity, because these appearances convey different impressions to different observers; and as a result of this discrepancy, we must admit the fact that "a large proportion of ordinary persons are very untrustworthy witnesses to identity when dependent on appearances alone. They are, from nature or habit, incapable of appreciating form, and form alone is the unerring proof of personal identity. The difficulties in the way of identification, more especially of the dead, are to them insuperable." To this inherent difficulty on the part of the witnesses may be added their want of previous training as minute observers, and also the well-known fact of the adroitness of criminals at personal disguisement.

A second means of establishing the identity of the living, especially in a criminal, is by certain peculiarities in the appearance, which are noticed at the time of the commission of the crime, and which are, therefore, apt to leave a strong impression on the senses, such as (*a*) size, when the individual is very tall or very short, very corpulent, or very slim; whether lame, or otherwise deformed; (*b*) dress, when a portion—sometimes a mere shred—of the prisoner's dress

is discovered near the seat of the crime, or which may have been retained in the grasp of his victim, and which exactly corresponds with the rest of the garment found on his person, or in his own house.

A third means of identification is afforded by the voice. Peculiarity of the voice (such as depth or shrillness, lisping or stammering) always makes a strong impression upon those who hear it, and constitutes a valuable aid in personal identification.

Fourthly, the presence of certain peculiar marks, either natural or acquired, about the person, often affords material aid in establishing identity. These marks comprise moles, nevi, scars, cicatrices, deformities, fractures, tattoo-marks, etc. Such marks are usually well known and remembered by relatives and friends of the individual, who can usually identify them. Some of these remain upon the body during life; others gradually decline and fade away. In relation to tattoo-marks, Casper's experience leads to the inference that some of them (the red ones) are gradually obliterated by time, while the black and purple ones are more permanent. A cicatrix is permanent during life, if there has been any original loss of substance. Even the cicatrix made by the lancet in venesection, at the bend of the arm, usually remains during life. It may not always be distinguished from the surrounding skin, unless the part be smartly rubbed, when the white scar is immediately manifested on the red surrounding surface. Caution should be observed against too strong reliance upon scars as a means of identity, since these may, at times, be discovered upon another, precisely similar, both as to form and situation.

Under this head may be mentioned the appearance of the hands (whether hard and horny, or soft and pliant, or

whether stained in a peculiar manner), as often indicating the nature of the occupation of the individual.

In no small number of cases now recorded, the teeth have been essential links in the chain of identification. Especially is this the case when the individual has been under the care of a dentist, teeth extracted, irregularity of tooth-line, fillings, and artificial teeth all being identifiable by the dentist who did the work.

Photographs and other portraits of the suspected person are sometimes useful aids in the identification of the living, as well as of the dead; but caution is requisite here, since the art of the photographer in the touching up of the picture frequently makes it an unfaithful representation of the negative.

As bearing upon this subject, it may be proper to say a few words upon vision and hearing. The limits of normal vision or healthy sight, unassisted by instruments, in a perfectly clear atmosphere, are stated to be as follows:

At a height of	5	feet, the range of distance is	2.96 miles.
" "	20	" " "	5.91 "
" "	50	" " "	9.35 "
" "	100	" " "	13.2 "
" "	500	" " "	29.5 "
" "	1000	" " "	41.8 "
" "	5000	" " "	94 "

It follows from this that a man of ordinary height may be seen on level ground at a distance of two or three miles on a clear day; but this is very different from recognition of the person so as to identify him. The effects of age upon the acuteness of vision are considered by Dr. De Guéret to be as follows:

At fifty years it is diminished one-fifth; at sixty years,

one-fourth; at seventy years, one-third; at eighty years, one-half. In other words, if a man of thirty or forty could distinguish an object at one hundred feet distance, at sixty years of age he could not recognize it further off than seventy-five feet, or at eighty years at fifty feet.

The recognition of persons at a nearer or greater distance is afforded by their stature, gait, complexion, color of the hair and eyes, and peculiarities of appearance. According to the above authority, the best-known persons can be recognized often with difficulty, in broad daylight, at one hundred metres, or about one hundred and nine yards. Less known persons may be recognized, in broad daylight, at sixty to one hundred yards; and people who are almost strangers, and who have no personal peculiarities, at twenty-seven to thirty-three yards. By the clearest moonlight, the best-known persons cannot be recognized further off than sixteen or seventeen yards. By starlight, recognition cannot be effected beyond ten to thirteen feet. The light of a flash of lightning enabled a lady, on her passage home from India, to see distinctly the features of a man who was robbing her trunk in the cabin of a vessel, on a very dark night; and authentic instances are given where, by the flash of a pistol or gun, sufficient light was momentarily afforded to enable not only an assailant to be recognized, but likewise the color and appearance of his horse.

The distance at which sounds (such as the report of a gun or pistol) continue to be audible cannot be determined with accuracy, since it depends upon the direction of the wind, the condition of the atmosphere as to moisture, and other disturbing sounds. The velocity of sound may be stated to be, on an average, 1135 feet per second, which is about 13 miles a minute, or one mile in about 4½ seconds.

II. The Identification of the Dead.—This may have reference (1) to the body recently dead, but entire; (2) when the body has been mutilated, and only parts of it are submitted; and (3) when the soft parts have disappeared by putrefaction and the skeleton only remains, or where detached bones merely have been discovered.

When the death has but recently occurred, and the body is unmutilated, most of the same general methods of establishing identity are available as have already been mentioned in the case of the living—such as the testimony of relatives and acquaintances as to the personal appearance of the deceased, certain marks upon the person, as nevi, moles, cicatrices, tattoo-marks, fractures, deformities, etc. Photographs and other portraits are here also admissible, although by no means reliable proofs.

If the body has been subjected to mutilation after death, and the several portions removed to a distance from one another, and some of them even destroyed, as is sometimes done by a murderer with a view to escape detection, the difficulty of identification is, of course, very much increased. Nevertheless, if the disconnected parts can be recovered, or even a portion of them, it will always be possible for a skilled anatomist so to readjust them as to reconstruct the body, so to speak, by making the proper allowances for the missing parts, and comparing these with other average specimens of a similar kind. Several striking examples of this character have been recorded. One of these is the well-known case of Dr. Parkman, who was murdered by Dr. Webster, in Boston, Mass., about forty years ago. After the death of his victim Dr. Webster attempted to destroy all evidences of the deed by cutting up the body into fragments, some of which were burned in a grate, some im-

mersed in chemicals, and others packed away in boxes in distant parts of the building. On the discovery of these remains, a week after the murder, the portions of the body were accurately examined by a skilled anatomist. It was proven that they were human remains, belonging to one and the same body; of the male sex; and that they had not been dissected for anatomic purposes, but cut and hacked in different directions, for the object, evidently, of mutilation. On restoring these disjointed parts *in situ*, and supplying the deficient portions, it was found that the proper measurements agreed closely with those of the missing Dr. Parkman. This circumstance, together with the discovery of certain marks of identity about the teeth and jaws (the head had been almost completely destroyed by fire), afforded sufficient evidence of the personal identity of the missing man to enable the jury, on the trial of Dr. Webster, to find a verdict of guilty. Another instance of a somewhat similar nature is recorded by Professor Taylor. A number of years ago a murder was committed in London, on the river Thames, and shortly afterward a package containing mutilated human remains was discovered on one of the abutments of Waterloo Bridge. The murderer had, no doubt, intended to throw the bundle into the river; but it had lodged on the projection in its descent. Dr. Taylor was requested to examine and identify these mutilated remains; and when, after great difficulty, the parts were brought together and found to fit, the body was identified as that of a man who had recently disappeared from a vessel on the river—a Swedish sailor. One of the most remarkable cases of this class was recently (1897) tried in Chicago, Ill. The defendant, Luetgert, was a sausage-maker, and was accused of having murdered his wife and

destroyed her body by solution in caustic soda in a vat in his manufactory. Some small bones and articles of jewelry were found in the vat. The trial lasted many days, but ended in a disagreement of the jury. The contention of the prosecution that the bones found were human was combated by experts called by the defense.

When the question of identity relates to the skeleton merely, or only to portions thereof, the answer cannot be always satisfactory, and the medical jurist has need of much caution and reserve before giving a positive opinion.

The very first thing for him to determine is whether the bones submitted to his inspection are human bones or those of some of the inferior animals. Doubtless, if the entire skeleton be discovered, there need be no uncertainty about the matter; but if only a single bone or two be found, a mistake may easily be made, except by a practiced anatomist and osteologist. Indeed, many ludicrous blunders are recorded of persons, of otherwise good medical education, mistaking the bones of the ox, horse, dog, pig, and goat for those of the human subject. But may not something be learned by the aid of chemistry or the microscope? The reply must be generally in the negative. Certainly, the bones of the aged do contain more calcareous matter than those of the young, and consequently present a somewhat different appearance under the microscope. But human bones have the same general chemical composition as those of the lower animals. Bone-cells or corpuscles vary somewhat in size in the different orders of animals, being largest in reptiles, smallest in birds and mammals, and intermediate in fishes. In this respect there is an analogy with the size of the blood corpuscles in these different orders; but these are only generalizations, and would be of little practical use

in individual instances. To be sure, the microscope will enable us to determine the fact of any specimen submitted being bone, or not, by the presence or absence of the bone-cells; but it can go no further, inasmuch as it cannot distinguish the bone-cell of a man from that of a mouse or of an elephant.

If the skull is the only portion of the skeleton submitted for examination, there can usually be no difficulty in recognizing it as human; the only doubt that might arise would be the possibility of its belonging to one of the higher order of (anthropoid) apes; but even here there are important differences which would not be overlooked by one skilled in comparative anatomy and osteology. The further question, whether from the examination of a skull simply, it is possible to decide to what race the individual belonged,—Caucasian or otherwise,—we do not think can be answered with absolute certainty. Doubtless, well-marked typical skulls may be identified as belonging to some particular race, *e. g.*, the Negro or Caucasian; but we must remember that the points of distinction, which in well-marked specimens serve to separate these, shade away in many instances so as to make it extremely difficult, if not impossible, to give a medico-legal opinion in an isolated case.

Another important point is to ascertain whether all the bones submitted for inspection belong to one and the same skeleton. The mere fact of their being discovered together does by no means necessarily prove it, since they might have been so placed either accidentally or with the design of eluding detection of some crime.

In the identification of the dead by means of the skeleton or by detached bones, the three leading points to determine are (1) the age, (2) the sex, and (3) the stature.

1. The Age.—This can generally, in young subjects, be pretty accurately determined by the development of the teeth and by the progress of ossification in the different bones. In the skeletons of new-born children, and before the teeth have appeared, it may become important for the medical jurist to be able to decide upon the age in order either to rebut or confirm a charge of infanticide. It is authoritatively stated that in the jaws of a child at full term there will always be found the rudiments of twenty-four teeth — twenty primary teeth and four permanent molars. Hence, if only the jaws of an infant be discovered, medical evidence of its probable age may be given. The average date of the eruption (cutting) of the teeth is, according to Mr. Bell, as follows: The four central incisors appear from *five* to *eight* months after birth; the four lateral incisors, from *seven* to *ten* months; the four anterior molars, from *twelve* to *sixteen* months; the four cuspidati, from *fourteen* to *twenty* months; and the four posterior molars from *eighteen months* to *three years*. Between six and seven years the jaws contain forty-eight teeth—twenty temporary ones in a perfect state of development, and twenty-eight permanent ones imperfectly developed and placed behind the temporary teeth which they are to replace. According to Mr. Saunders, the order in which the permanent teeth make their appearance is as follows: At *seven* years, the four anterior molars; at *eight* years, the four central incisors; at *nine* years, the four lateral incisors; at *ten* years, the four anterior bicuspids; at *eleven*, the four posterior biscuspids; at *twelve to twelve and a half* years, the four cuspids; and at *thirteen to fourteen* years, the four second molars—making the whole number of permanent teeth at this period *twenty-eight*. The four remaining (pos-

terior molars) teeth—called wisdom teeth—do not usually appear until from eighteen to twenty-one years of age. As a rule, the teeth of the lower jaw are cut first, but there are many exceptions; nor must it be forgotten that irregularities often occur as to the order of their appearance. The above description is intended to apply only to the average cases.

To cite one or two examples in illustration of the medico-legal application of the foregoing rules: suppose the skull of a child was discovered, in the jaws of which were *twelve* permanent teeth—eight incisors and four molars; we should decide the age to be about *nine* years. If the jaws contained *twenty-four* permanent teeth—eight incisors, four molars, eight bicuspids, and four cuspids, we should conclude the age to be about *thirteen* years; and so on. It is proper here to remark that there are two diseases which affect the growth of the teeth, viz., rickets and syphilis. In a rickety child the first teeth do not usually appear until after the twelfth month, whereas in cases of congenital syphilis the teeth appear prematurely—before the sixth month; but they present a peculiar notched appearance, and they are apt to be brittle and to crumble away easily.

The progress of ossification in the different bones of the skeleton affords an additional test of its age, especially in early life. According to Béclard, the degree of ossification in the lower epiphysis of the femur affords the most certain criterion of the age of the fœtus and of the new-born child. Thus, if no ossific deposit can be seen in this cartilaginous epiphysis, it is certain that the fœtus has not attained to the eighth month of uterine life. If the osseous deposit is as large as a poppy-seed, it is probably in the ninth month of

fœtal existence; and if it has acquired the diameter of a line and a quarter, to one and a half, it has reached the full period. If the point of ossification measures three lines or more, it may be assumed that the child had survived its birth some little time.

The average length of the skeleton of a new-born child is about sixteen inches. At the end of the first year, ossification has commenced at the extremities of most of the long bones; and this progressively advances from year to year until the whole process is completed, and the epiphyses of all the long bones become united to their shafts at full maturity, which, in the male, may be considered to be twenty-four years, and in the female, twenty-two years. After this period, or when ossification is once completed, it is difficult to determine the precise age by an examination of the bones of the skeleton. It should, however, be remembered that the different bones of the sternum do not unite until about the fortieth or forty-fifth year; and union between the sacrum and os coccygis is not usually completed until fifty-five or sixty years of age.

In old age, the bones become lighter in weight and more brittle, from the loss of animal matter. They are also darker in color; and the flat bones become thinner, from the absorption of the diploë. In the skull of the aged, the sutures are more or less obliterated; and the remaining teeth present a worn appearance, and a yellowish color. If the teeth have been lost (as is usually the case, at least in this country), the alveolar processes become absorbed, and the lower jaw undergoes a well-marked change in its appearance, consisting of the widening of the angle at its neck, and the shortening of the vertical diameter of its body, or width, which imparts the characteristic senile expression to the

mouth of the aged. The discovery of such a jawbone would positively determine the age to be about seventy years or over.

The presence or absence of certain teeth in the head has frequently been the means of determining the identity of the body. So, also, the presence of artificial teeth, with their mechanical appendages, has at times furnished the strongest corroborative evidence in such identification, as in the celebrated Parkman-Webster case, already alluded to, in which the artificial teeth, discovered undestroyed by the fire in the grate, where the head had been burnt up, were positively identified by the dentist who had manufactured and fitted them some years before. So, likewise, the remains of the Marchioness of Salisbury, discovered among the burnt ruins of Hatfield House, were identified by the jawbone having gold appendages for artificial teeth (Guy). The importance of the teeth as a means of identification is shown in the case of the late French Prince Imperial, killed in battle; his body had been so much disfigured by his savage assailants that its identification would have been extremely difficult but for certain peculiarities about his teeth.

II. The Sex.—This can usually be determined from the skeleton, if entire, without much difficulty. The male and female skeleton present many well-defined points of difference, which are described in all anatomic works. The corresponding bones of the two differ in size, weight, strength, and prominence of their ridges and protuberances which mark the points for the insertion of muscles. There are also certain recognized differences in the head and thorax; but it is in the pelvis that the most characteristic distinctions are observed. The male pelvis is narrower and

deeper than that of the female. In the latter, the iliac bones are more spread out, and flatter, which renders the superior part of the pelvis more capacious; the sacrum is broader, and turned more backward; the arch of the pubis is much wider. The greatest diameter is the bilateral; whereas in the male, the antero-posterior is the greater. The foramen ovale is triangular in the female; in the male, it is more oval. Owing to the greater breadth of the female pelvis, the acetabula are farther apart than in the male. It is to be understood that these peculiarities in the female pelvis are not clearly exhibited before the period of puberty. From a fragment of a bone it would certainly be hazardous to undertake to determine the sex; and care should be exercised in giving an opinion in such a case.

III. The Stature.—If the whole skeleton has been preserved, and none of the ends of the long bones have been lost by decay, the original height may be calculated with tolerable accuracy by arranging the bones *in situ*, and adding an inch and a half to two inches to the entire length of the skeleton, to supply the loss of the soft parts. But even here perfect accuracy cannot be attained, chiefly on account of variations in the curve of the spinal column in different individuals. Dr. Dwight assumes, as the result of numerous observations, that the total height of the intervertebral cartilages is 25.6 per cent. of the entire length of the spine. As a collateral aid in estimating the stature, we may regard as correct the generally accepted rule that the top of the symphysis of the pubes is about the centre of the body in average women; while in men, the centre is a little below the symphysis.

The attempt has frequently been made to estimate the

height of the body from a study of the individual long bones of the skeleton ; but no reliance can be placed upon such comparisons, inasmuch as there is considerable variation in the length of these bones in skeletons of the same stature. The so-called "rules of proportion" of certain writers cannot be regarded as by any means certain or authoritative. In case the skull is wanting, the rule laid down by Dr. Gould is "to find the height of the spine of the seventh cervical vertebra from the ground, and add to this 9.95 inches, which is the average height from this point to the top of the head." De St. Lucca states that there is a general proportion between the different bones of the body and the stature, and that an approximative estimate of the stature may be had by measuring the length of the first phalanx of the middle finger, thus : this phalanx is equal in length to one-fourth that of the whole hand, including the carpus ; and the carpal and metacarpal bones together represent one-half of the hand. The arm may be divided into five parts, of which two are included in the humerus, two in the fore-arm, and one in the hand. The total length of the hand is, therefore, one-fifth of the arm. Double the length of the arm (or the two arms stretched out horizontally), added to the length of the two clavicles, together with the transverse diameter of the sternum, is equivalent to the whole length of the body. In applying this rule to practice, however, we must not forget that the length of the hand, and especially that of the fingers, varies materially in persons of the same height ; and so trifling a variation in the first phalanx of the middle finger as the one-sixteenth of an inch would, according to this method of calculation, figure up as great a difference in the total

result, for the height of the whole body, as two and a half inches.

The existence of fractures, deformities, and callus in a skeleton sometimes affords valuable aid in its identification, even many years after death. In relation to the production of callus, it is well understood that this substance is the result of the reparative processes in bone, and that its presence is a certain indication that some time must have elapsed between the injury to the bone and the death of the individual. On the other hand, the total absence of callus on a fractured bone, indicating that no time had been given for the process of repair, would be very good evidence that the injury was the immediate precursor of death, and if on the skull, the probable cause of death. An instructive illustration of this is given by Taylor in the case of an Englishman, who was tried in India for the murder of a native who had been beaten with a stick, the allegation being that a rib had been broken, thereby causing his death. To substantiate this charge, a skeleton was produced which had been dug up three months subsequent to the decease of the alleged murdered man, which was almost completely denuded of flesh ; the bones clean and dry ; one rib fractured, with a deposit of callus around the fracture. The identity of these bones with those of the missing man was attempted to be established by the prosecution, but unsuccessfully, in consequence of their dry and denuded state—a condition altogether incompatible with so short a period of time as three months since death. Moreover, the amount of callus thrown out made it evident that more than a week must have elapsed before death took place, which event was alleged to have occurred immediately after the injury.

Other notable instances might be mentioned of the identification of the skeleton by means of the above-mentioned marks, or peculiarities, and even where it was possible to determine the actual cause of the violent death. In the year 1823, a soldier living in the south of France suddenly disappeared under suspicious circumstances. Two years, however, elapsed before any investigation was instituted by the proper authorities. Some human bones were then discovered in digging in the garden of the deceased soldier. Of course, it became necessary to identify these remains. It was remembered that the deceased had a singular personal deformity, in possessing a sixth finger on the right hand, and a sixth toe on the left foot. On examination, it was ascertained that the fifth metacarpal bone of the right hand was shorter and broader than the corresponding bone of the other hand, and further, that there were two articulating surfaces on its digital end, indicating clearly the existence of a supernumerary finger. In the same way the fifth metatarsal bone of the left foot showed two distinct articulating faces on its digital extremity, indicating the existence of a supernumerary toe. Besides this, the age, sex, and stature of the skeleton corresponded with those of the missing man. But even further than this, a close inspection of the skull revealed the distinct marks of a depressed and radiated fracture of the temporal bone, which showed no sign of reparation by the formation of callus. Evidently, then, death had occurred very soon after the fracture of the skull, and in all probability as the direct result of violence. Upon this evidence, the suspected parties were tried and executed, having previously confessed their crime.

Sometimes, on the exhumation of bones, the question

arises as to how long they have been buried. After all the soft parts have disappeared, which commonly requires about ten years, it is only possible to give an approximate estimate. In a dry soil, bones will resist decomposition for thirty or forty years after burial ; and if preserved out of the ground, as in the crypts of old churches, they may last for hundreds of years. As the process of decay progresses they become lighter in weight, in consequence of the loss of animal matter, and the color externally grows darker. The ends gradually become brittle and crumble away, and finally the shaft of the bone undergoes a similar disintegration, the mineral matter alone remaining unaltered. Devergie states that the bones of King Dagobert were found in a state of tolerable preservation, enclosed in a leaden coffin and sarcophagus, at St. Denis, after the lapse of twelve hundred years ; and Dr. Taylor mentions that the skeleton of William Rufus was found in a stone coffin at Winchester nearly perfect, after seven hundred and eighty years' burial. The bones of Abelard and Héloïse were so well preserved that after a lapse of five hundred years the female skeleton could readily be distinguished from the male.

Even if the bones have undergone calcination, as when a body has been burned with a view of destroying its identity, especially in cases of infanticide, it may still be possible to determine whether the remains are human, provided the bones preserve their proper form and have not been reduced to powder.

Other means of personal identification are afforded by a microscopic examination of the hair and the fibres of various sorts of fabrics, such as cotton, wool, and silk. Human hair discovered on a weapon, along with blood stains,

affords strong presumptive evidence of murder or violence. So, also, fibres of cotton, or of other material, found on weapons supposed to have caused death, or else on the person of the accused, suggest a strong suspicion, if these fibres correspond to the clothes of the deceased. Thus, a case is mentioned by Taylor, where the discovery of some cotton fibres, accompanied by a blood stain, upon the edge of a razor, found near a woman, whose throat had been cut while in bed, led to the subsequent detection of the murderer. In the same manner, the discovery of a few hairs upon the handle of a knife, on which also were marks of blood, enabled a London microscopist to declare that these hairs were squirrel hairs ; which circumstance further led to the identification of the murderess of a child, whose throat had been cut with a knife, which, in the death wound, had passed through a victorine made of squirrel fur worn around the child's neck.

In case of rape, the examination of the hair about the female genitals will be likely to show the presence of seminal spots and of spermatozoids.

In all cases, except when hairs are to be examined for spermatozoids, they should be washed in warm water and then thoroughly dried, afterward steeped in turpentine, and finally mounted in Canada balsam. They should then be examined with a magnifying power of about 200 diameters. To examine hairs for spermatozoids, moisten first of all with a drop of ammonium hydroxid solution, and examine under a microscope after the liquid has evaporated.

For the identification of hairs, human or other, it is desirable to have at hand specimens of various kinds of these, properly mounted for comparison. Hairs resist putrefaction for a long time. It should also be remembered that

hair is affected differently by different reagents. Strong alkalies dissolve it ; acids roughen it ; alcohol causes it to look clearer ; chlorin water bleaches and rots it.

The size of hairs from different parts of the human body, as well as from different individuals, varies considerably ; thus, the hairs from the head are finer than the eyelashes, but coarser than the hairs from the arm. There is also considerable difference in the size of the hairs of the various lower animals.

The main medico-legal questions connected with the identification of hairs are : (1) Is the hair human, and from what part of the body ? (2) Does it correspond with the hair of the murderer or of the victim ? (3) Has its color been naturally or artificially changed ? It should be remembered that gray hair is not infrequently found on comparatively young persons, and that undoubted instances have occurred of the sudden bleaching of the hair through fright or grief. As regards the artificial coloring of the hair, it is well known that this is one of the means of disguise most commonly adopted by criminals in order to elude detection.

The common hair dyes for coloring light or red hair black or brown, are composed of the salts of lead, silver, or bismuth. Hair thus colored may easily be detected by soaking it in nitric acid, which dissolves out the mineral, which may then be identified by the appropriate tests. It is more difficult to bleach or whiten the hair than to darken it. This is usually effected by washing it in an alkaline solution to remove grease, and then soaking it in chlorin water or hydrogen dioxid solution, which will lighten the tint in a few hours. Chlorin water renders the hair very brittle and imparts an odor to it.

In all artificially colored hair, the fraud can be detected by closely watching the new growth, which will be of a different color from the other portions ; and also by chemical tests.

The fibres of cotton, linen, wool, and silk all present well-marked differences when viewed under the microscope. The cotton fibre is in the form of a flattened band, with thickened borders, and is spiral or twisted upon itself. Linen consists of round fibres, having a firm consistency, with jointed transverse markings at unequal distances, somewhat resembling those on the India cane and tapering to a point. Silk fibre has the appearance of straight, well-defined cylinders, free from all markings and refracting light powerfully. Wool fibre is irregular, wavy, and of unequal thickness. The fibres of hemp resemble those of flax (linen), but are coarse ; and when boiled in nitric acid they exhibit no spiral streaks, but swell and become brittle.

The identification of blood stains and seminal spots will be treated of later.

CHAPTER VI.

CAUSES PRODUCING VIOLENT DEATH.

The third important question requiring decision in every case of violent death is the cause of the death. These causes are numerous and diversified, but may be considered under the following heads:—

Wounds.	Drowning.
Burns and Scalds.	Electricity.
Suffocation.	Heat and Cold.
Strangulation.	Starvation.
Hanging.	Poisoning.

VIOLENT DEATH FROM WOUNDS.

A **wound** is a solution of continuity, in any tissue, produced by violence. It may be subcutaneous—that is, beneath the skin—or it may be open; further, wounds may be superficial or deep; they may be incised, punctured, contused, lacerated, poisoned, gunshot, etc. Penetrating wounds enter cavities, but do not emerge; perforating wounds both enter and emerge from the cavity.

A distinction is sometimes made between mortal and non-mortal wounds, or between wounds dangerous and not dangerous to life, and the medical witness is asked to give an opinion on this subject. He should be guarded in his answer, since it is well known that many wounds at first considered as comparatively trivial, may assume a dangerous and even fatal character. Of course, in many cases

there would be no difficulty in pronouncing upon the dangerous or mortal character of a wound; for instance, wounds of the heart or the great vessels or internal viscera, or compound fracture of the skull. The danger of a wound depends upon many circumstances, all of which should be considered, such as: position; relation to the great vessels and nerves; weapon by which it was inflicted; amount of hemorrhage; age; constitution and general health of the subject; circumstances (favorable or unfavorable) for treatment. Medical testimony is usually required only in case of a fatal termination, except in the case of assault, when the character of the injury (whether dangerous or trivial) might decide as to the propriety of accepting bail for the prisoner.

In case of death from a wound, the medical examiner should never theorize as to the manner of its causing the death; and he should give his opinion only after a very careful post-mortem examination of the body. Moreover, as before mentioned, the examination should not be confined simply to the wounded portion of the body, but all the cavities and organs should be inspected, since it may be affirmed that a natural cause of death might have existed in that very part which was neglected by the examiner. Such neglect has often occasioned a doubt in the minds of the jury as to the real cause of death. It may be necessary to examine the stomach for poison, as shown by the oft-quoted instance recorded by Wildberg, of the girl who was beaten by her father for stealing, and who died shortly afterward, apparently from the effects of the blows, but in whose stomach a considerable quantity of arsenic was found. She had swallowed the poison soon after committing the theft, fearing her father's anger. The accused was

discharged. In a similar manner it sometimes happens that a person, after taking poison with suicidal intent or after stabbing himself through the heart (death not being instantaneous), may destroy himself by another means, as by a gunshot wound, by drowning, or by throwing himself from a window or a precipice.

The examination of the wound includes the observation of its situation, extent, and direction ; the presence or absence of effused blood, whether liquid or coagulated, and the presence of ecchymoses ; the condition of the edges of the wound, whether everted or not ; whether adhesion has commenced ; the presence of granulation, inflammation, suppuration, or gangrene ; whether it was inflicted before or after death ; whether there is loss of substance, or hernia of the viscera. The clothes of the deceased should be inspected to ascertain if the rents or perforations in them correspond with the wounds of the body. If the weapon, say a knife, with which the wound is alleged to have been made, is at hand, it should not be used in the examination or comparison with the wound. Another instrument exactly like the one in question, or a piece of wood shaped like the supposed weapon, may be substituted. The following recent case is in point : An old man was found dead, with his throat cut, and the butcher-knife with which the wound was alleged to have been produced was fitted into the wound in the neck. Later it was found that this particular knife had been used a short time previously by the defendant in killing poultry, and he maintained that the blood found on it at the inquest was that of a chicken or turkey. The microscope afterward showed the presence of both mammalian and oviparous blood ; but the knife having been placed in the wound post-mortem, rendered

the evidence adduced by the microscopic examination of no value.

In cases of severe injury it sometimes happens that death results from internal lesions, with few or no external marks. According to Casper, this is of frequent occurrence in severe internal lacerations occasioned by violence. He cites an illustrative case: A wagoner, in guiding a team drawing a loaded wagon down a hill, was accidentally crushed against a tree on the road. He was found dead the next morning. The only external injuries were a slight abrasion upon the left arm, and one upon the right temple. On opening the body, however, the most striking evidences of violence were discovered. From the spinal canal about a quart of blood escaped. The spinous processes of the first thoracic vertebræ were broken off. The left pleural cavity contained about thirty ounces of fluid blood. The pericardium was torn completely across; and the heart, severed from its large vessels, lay almost entirely loose in the cavity of the thorax. The open ends of the aorta and pulmonary artery were distinctly visible. The left lung was entirely torn through its middle portion; and in the right lobe of the liver was a laceration two inches long and half an inch deep.

The distinction between wounds made before and after death must be carefully noted. Wounds inflicted before death may be recognized by the following signs: (1) Incised wounds exhibit everted edges, arising from the elasticity of the skin and subjacent muscles, with considerable hemorrhage, usually of an arterial character; spots of arterial blood which have spouted on to neighboring surfaces are of a peculiar comet-like shape. Coagula are more or less

abundant in the wound, and around it. The surrounding tissues are more or less infiltrated with blood. If some days have elapsed before death, evidences of vital reaction will be shown, such as partial healing, granulation, suppuration, or sloughing. If the wound was made immediately after death—within a few minutes—there may be some retraction of the skin and some slight bleeding, with few or no coagula, which are of loose texture. There is little or no staining of the surrounding tissues, and never any attempt at repair. If the wound be made ten or twelve hours after death, there will be no eversion of its edges, no hemorrhage, except of a slight venous character, and no surrounding infiltration. The experiments of Taylor and Aston Key upon amputated limbs confirm the above description. The amount of hemorrhage accompanying an incised wound affords a pretty good criterion as to whether it was inflicted before or after death. Comparatively little bleeding, chiefly venous, accompanies wounds made after death ; while in the living, the hemorrhage is chiefly arterial. In a case of murder reported by Casper, as also in the case of Greenacre, in England in 1837, in which the head of the victim was severed from the body, the fact that the head was completely drained of blood led to the conclusion that the decapitation had been done during life, and that there must then have been a copious hemorrhage to account for the absence of the blood after death.

(2) In lacerated and contused wounds the distinction is not so obvious as in incised wounds. Lacerations are not always accompanied by bleeding, but there will always be more or less coagula present ; and if the person survives a few days, there will be evidences of vital reaction, such as suppuration and granulation, sloughing or gangrene,

all of which are absent in such wounds inflicted after death.

Contused wounds made during life are chiefly distinguished by the amount of effused blood in the cellular tissue under the skin (ecchymosis). This arises from the rupture of small vessels, and is manifested by the well-known "black and blue" discoloration produced. If the effusion of blood is rapid, the spot is dark red at first; if slower, the discoloration is deep blue or violet. In some cases of even violent contusion, there may be no appearance of external ecchymosis. Again, it is not always manifested immediately over the seat of the contusion, but at a little distance from it, especially if the surrounding tissue is loose. Familiar illustrations of this are afforded in the case of a blow over the eye, producing an ecchymosis of the lower lid; and of a blow over the lower portion of the abdomen being attended with ecchymosis of the scrotum. The presence of ecchymoses, then, in cases of contused wounds, may be regarded as pretty good evidence of the ante-mortem character of the injury, while its absence is not necessarily an indication that the wound is post-mortem. The experiments of Christison upon the dead body go to show that if the contusion be made very soon after death, and while the body is still warm, the resulting appearances strongly resemble those produced by ante-mortem contusion—so much so as to be easily mistaken for the latter; with this difference, however, that the effusion is usually immediately beneath the skin, and not in the areolar tissue; also that there is an absence of coagula and of swelling.

Ecchymosis is usually superficial, and may appear very shortly after the injury; or it may be deep-seated and not

visible at all. In some instances it is not manifested until after death, as in the case of a man who died from rupture of the bladder resulting from the kick of a horse, thirty-five hours after the injury ; no discoloration of the abdomen was observed until after his death. Neither can the quantity of blood effused nor the extent of the injury be always estimated by the amount of the discoloration. This is well illustrated in Casper's case of the wagoner who was crushed to death.

Another important fact relative to ecchymoses is the change of color which accompanies them, since this may serve to indicate the probable date of the contusion. In about twenty-four hours the blue or livid margin of the bruises becomes lighter, or of a violet color, which gradually changes to green and yellow. During these alterations of color the spot may become larger, but the central portion remains always darker than the margins. The color is finally absorbed and entirely disappears. In general, the ecchymosis shows itself within twelve hours after the contusion ; the violet color within three days ; the green, from the fifth to sixth day ; the yellow, from the eighth to tenth day ; and, in healthy persons, the complete disappearance of the spot occurs from the twelfth to fourteenth day. The changes are more rapid in the young than in the old, and depend also on the degree of the contusion. The above changes of color never appear in contusions on the dead, which circumstance constitutes another diagnostic mark.

It is also important not to mistake the ecchymosis proceeding from natural causes, such as scurvy, petechia, and purpura, for that occasioned by blows. The former may usually be distinguished by being confined to the superficial layers of the skin, and by their presence also on the

internal mucous membranes, together with the absence of swelling and the fluidity of the blood.

According to Devergie, ecchymoses are often concealed on the bodies of the drowned when first they are removed from the water, owing to the sodden state of the skin ; they may become apparent only after the body has been exposed for some days and the water has evaporated.

(3) In punctured and penetrating wounds, the diagnosis between those inflicted before and those produced after death is usually not difficult. The former are attended with hemorrhage, and often exhibit signs of vital and reparative reaction, such as inflammation and suppuration, or gangrene. The latter are destitute of all these. For example, a stab made into the left ventricle of the heart after death is followed by no hemorrhage.

Where inspection does not satisfactorily prove the antemortem characteristics of a wound, the microscope, in the absence of advanced decomposition, will be found invaluable. Suitably made sections will show the presence of the processes of repair and the dissolution of blood thrown out during the injury. In the case of the Commonwealth *vs.* Schmidt, the question of homicide or suicide turned upon the age of certain bruises upon the body of the deceased. Microscopic examination showed the subcutaneous tissue to be far advanced in the process of repair, and positively excluded their having been produced a few hours before, or immediately preceding death.

As regards the particular weapon that may have caused the wound, it is not always possible for a medical witness to give a decided opinion ; but it is desirable, if possible, to establish the relation of the injury with its supposed

cause; thus, an incised wound would naturally be referred to a cutting weapon; a penetrating wound to a pointed one, a bullet or missile; and a contused wound to a blunt instrument; but caution should be observed in giving an opinion on this subject, especially in case of contused wounds.

Incised wounds are characterized by the regularity and evenness of the cut. This usually serves to distinguish them from wounds made by glass and crockery ware or nails, which are generally irregular and uneven; but in some instances the cuts produced by broken glass or china exactly resemble incised wounds. In stabs the shape of the wound may often indicate the character of the weapon, whether double-edged or not, but when the weapon has penetrated obliquely through the tissues, and when these have been stretched, the shape of the wound will not exhibit this correspondence. So, also, a wound made in parts where the skin is wrinkled may suggest the idea of several distinct wounds, as in the neck. It must not be overlooked that superficial incised wounds may give rise to dangerous or even fatal hemorrhage; and, also, that it is not always possible, in such cases, to determine the direction of the incision—*i. e.*, whether made from right to left or the reverse; and yet, as remarked by Casper, this fact might have a most important medico-legal significance in determining the question whether the wound, as in cutting the throat, was homicidal or self-inflicted. The attendant circumstances, however, might throw some light upon it, such as the presence of blood on the right or left hand, or cuts on certain parts of the clothing of the deceased.

Lacerated and contused wounds do not afford the same facility for identifying the weapon as incised wounds. From simply inspecting them it will not generally be possible to

indicate the precise weapon or cause. It may, indeed, be possible to say that it was not produced by a cutting instrument; but a blow made by a blunt weapon upon the skull or over the zygoma may give rise to a cut which strongly resembles an incised wound, though, as a rule, the division of the parts is not as straight and regular as in the latter and the angles of the wound are less acute. Moreover, in the contused wounds there is more or less swelling, and extravasation of blood into the adjoining parts; and, at times, the existence of irregular fracture and internal hemorrhage.

In the case of a fatal contused wound of the head, it has been judicially decided that it makes no difference as to the guilt of the accused whether he produced the death of his victim by a direct blow upon the head, or indirectly by causing him to fall upon a stone or other hard substance which produced the fracture or contusion.

As before mentioned, rupture of the internal organs—the liver, spleen, heart, lungs, and kidneys—is a frequent result of contusions. Fracture of the base of the skull is sometimes caused by severe contusion of the head. Wharton and Stillé allude to the fact that spontaneous wounds sometimes occur in the labia and vagina of pregnant women, which might give rise to suspicion of assault. Also, that in such women accidents of different kinds are frequently attended with profuse hemorrhage from the pudenda.

It is evident from what has been said in reference to the difficulty of always connecting a contused wound with the precise instrument that caused it, that the witness should avoid committing himself upon the question. In some instances, however, the shape of the contused wound, especially a depressed fracture of the skull, will enable us to

come to a correct conclusion on the subject. Some years ago Dr. Reese was called upon, as an expert, to testify as to the probable cause of a depressed fracture of the temporal bone of a man who had been struck during a general fight. The question was whether the injury had been inflicted by the fist merely, as was alleged, or by an instrument like a loaded cane or billy. From the private confession of a comrade of the prisoner there was good reason for believing that the latter instrument, in the hands of another person, was the real cause of his death. The fractured bone was produced in court. The depression was well marked, a quarter of an inch deep, exactly corresponding to the loaded end of the billy. Radiating fissures (as would probably have resulted from a blow of the fist) were not seen. The opinion of Dr. Reese, founded on the above facts, was that the fatal blow had not been inflicted by a fist, but by a billy, but two physicians on the other side opposed this view. The judge dexterously solved the mooted question by asserting that, in such cases, one expert was about as good as another, and inasmuch as in the present trial there were two against one, he would decide in favor of the majority; and so he did, and the prisoner (possibly an innocent man) was convicted and sent to the penitentiary.

The examination of the clothes of the deceased constitutes an important part of the physician's duty, as this may throw light upon the mode in which the wound had been made, from the character of the cuts or stabs observed upon them. So, likewise, marks of blood, dirt, grass, or other substances on the clothing may afford valuable indications in the same direction. The same remark applies to fragments of the clothing of either the deceased or the pris-

oner discovered near the dead body and agreeing with the clothes worn at the time. Contused wounds by bludgeons may, however, occasion considerable laceration of the muscles, or even severe fractures, without tearing the dress.

Taylor mentions an instructive case, showing the importance of comparing the articles of dress with the injuries which may have proved fatal. A woman, aged sixty, was found one morning dead in her bed. She had been seen in her usual health on the previous night. On inspection, there were found two indentations in the right parietal bone, and a large clot of blood in this situation, beneath the skin, together with a fracture of the bone four inches in extent. Beneath the bone on the dura mater were found nearly three ounces of clotted blood. On the evening before her death she had been suddenly knocked down on the public road by a man accidentally running against her. She fell heavily on the back of her head, appeared stunned, was raised upon her feet, and, after drinking some brandy, recovered sufficiently to walk a mile and a half and eat supper. There was a suspicion of murder, in this case, against a fellow-lodger; but when the bonnet worn by the woman was produced at the inquest, two indentations were discovered on the back part of it corresponding to those on the skull of the deceased. The indentations on the bonnet, moreover, contained dust and dirt, thereby confirming the statement of witnesses who had seen her fall, and rendering it highly probable that this fall was the real cause of the fatal fracture and effusion of blood. It also illustrates the well-known fact that a person may receive a fracture of the skull, ending in effusion, which may not prove fatal for many hours after the accident, and which may not have prevented

the individual from walking a considerable distance after the injury.

Was the wound homicidal, suicidal, or accidental ? This important question cannot always be settled by medical testimony alone, though there are many points in which it is of the greatest aid. These are as follows :—

1. *The Situation of the Wound.*—Suicidal wounds are usually inflicted upon the most accessible parts of the body, such as the head, neck, breast, and abdomen. If by firearms, the part usually selected is the head (mouth, forehead, or temple) or over the heart; if by a cutting instrument, the throat or heart. The discovery, therefore, of wounds on a part of the body difficult to reach by the individual himself, as the back, would certainly not be suggestive of suicide; but an exception must be made here as regards the insane, who are well known to destroy themselves by self-inflicted wounds of the most extraordinary character on the back of the head and neck, by striking the head against some solid substance, or by precipitating themselves from a height. An insane person (as also the sane) has been known to shoot himself with a pistol fired from behind the ear. The situation of the wound is, therefore, only suggestive of its origin, since it is quite possible that an assassin might inflict a death wound upon his victim in such a situation designedly, in order to deceive, and thus elude the suspicion of homicide. Accidental wounds are usually met with on exposed parts of the body.

2. *Nature and Extent of the Wound.*—Suicide is rarely inflicted by contused wounds, but usually by incised or penetrating ones. Exceptions occur, as when a person throws himself out of a window or from a height; and, in some remarkable instances of self-destruction in the in-

sane, by butting the head against a wall, and subsequently chopping it with a hatchet. In the case of the insane, there is no accounting for the variety in the nature and extent of the wounds inflicted for the purpose of self-destruction. This fact ought to be remembered, since, if the bodies of such persons should afterward be discovered, and nothing be known of their previous histories, serious errors in relation to the real origin of the wounds might result.

Incised wounds of the throat are often regarded as indicating suicide; but it is well known that murderers frequently destroy their victims by cutting their throats. As to the extent of the wound, it is commonly supposed that a suicidal incision of the throat does not reach as deeply as a homicidal one of the same character; but instances are not wanting where a determined suicide has severed the throat down to the vertebræ. Again, irregularity in the cut of the throat has been deemed by some as indicating homicide rather than suicide, under the idea of resistance on the part of the victim; but it is evident that the irregularity might have resulted equally from nervousness or indecision in inflicting the wound on the part of the deceased.

The nature and extent of the wound or injury may serve to distinguish accident from homicide. Thus, if numerous wounds or bruises are discovered in opposite sides of a dead body, the presumption would be in favor of homicide; and when the accused attempts to ascribe the death of his victim to a fall, the nature of the wounds might be such as positively to contradict his assertions.

3. *Direction of the Wound.*—This will often enable us to distinguish between a homicidal and an accidental wound rather than to decide upon its suicidal character. Thus, if

death has occurred from a stab, inflicted downward from the upper part of the thorax and penetrating the heart, as did happen in a certain case, and it was attempted on the part of the prisoner to show that the wound had been accidentally occasioned by the deceased falling, while drunk, downward upon the knife which the prisoner had held in his hand sloping upward, the downward direction of the wound would prove the falsity of the statement. Two other cases may be quoted from Wharton and Stillé of a similar character. One is that of a man discovered dead, with a deeply-punctured wound of the neck, which, on examination, showed that the weapon had been partially turned and withdrawn, and again plunged into the neck in a different direction, after the manner of the German butchers. This circumstance proved not only that the death was not accidental, nor probably suicidal, but pointed to a homicide, and also indicated the occupation of the murderer. The other occurred in England, some years since, where a murder was fixed upon a man from the fact that the wound in the neck of the deceased had been evidently made by a knife cutting from within outward, as is done in slaughtering sheep.

In most suicidal wounds of the throat it is found that the cut has been made from left to right; in punctured wounds the direction is commonly from right to left and downward. In left-handed persons the direction would, of course, be the reverse. These facts, however, can only afford moderate presumptive evidence, since it is obvious that a murderer might inflict an incised wound in the throat of his victim from behind, which would exactly resemble that made by the suicide. In all such doubtful cases particular attention should be directed to the surrounding

circumstances, such as the position of the body and the weapon, the presence or absence of blood upon the hands and person of the deceased, etc. If the death has been very sudden, from hemorrhage (in a case of suicide), the weapon will most probably have fallen from the hand, on account of the relaxation of the muscles; but if it has been caused by a pistol, the weapon may be found tightly grasped in the hand of the deceased. If the throat has been cut suicidally, blood will be found on one or other of the hands; but if homicidally, and no resistance has been made, the hands will probably be unstained. As regards the position of the body, if the death be very sudden, from loss of blood, the body will be found lying on the back; if less sudden, the face and trunk will be turned toward the ground. If the body be found upon the back, in death from hemorrhage, and the weapon at a distance from it, the act was, in all probability, homicidal.

The position of the weapon in relation to the dead body, although at times strongly suggestive, can never afford absolute evidence as regards the question of homicide or suicide. Thus, Casper mentions the case of a man who cut his throat with a razor, which was found bloody and closed, two feet distant from the body. Also, of another suicide by a pistol-shot in the breast, where the pistol was found in the pocket of the deceased, who had afterward terminated his life by drowning himself.

From what has been said above, it is manifest that the witness can rarely venture to give a positive opinion as to the homicidal, suicidal, or accidental cause of death, apart from a consideration of the circumstances accompanying it. These circumstances vary in every case, and it requires the utmost experience and tact on the part of the medical

examiner to recognize and apply them in each individual instance. Some of them have already been noted: they include the position of the body and the weapon; the condition of the ground where the wound was inflicted; the presence of footprints; the condition of the clothing of the deceased; the condition of the hands, whether showing wounds or cuts on their palms (indicating resistance), or the hands holding portions of hair or fragments of the assailant's clothes; the adherence of certain fibres to a weapon, such as cotton, woolen, linen, silk, or fur; marks of blood upon clothing or furniture; state of the mouth and throat; marks of blood or other matters on the person of the assailant; rifling of the pockets and tearing of the dress, etc. These cannot be further enlarged upon here; but their medico-legal importance cannot be too strongly enforced.

When two distinct wounds are found upon a dead body, either of which is sufficient to have caused death, the question may arise whether this was a case of suicide or homicide. Is it possible for a person to inflict upon himself, consecutively, two mortal wounds, say by shooting one bullet through his brain, and another immediately afterward through his heart?

There can be, it seems, no question about the possibility of the self-infliction of two mortal wounds, provided the first one was not instantaneously fatal. It is well known that a stab or bullet through the heart or a pistol-shot through the brain is not immediately fatal, so that ample time is allowed for the repetition of the fatal act on the part of the suicide.

Moreover, it is within the bounds of possibility that, after the first fatal shot from a self-cocking pistol, a second

discharge from the weapon may have been a mere automatic act—the victim's finger being at the time on the trigger, and thus producing the discharge unconsciously. It might even happen that this second unconscious and chance shot might produce a fatal wound upon another person, and thus give rise to the question of an intentional or accidental homicide.

Gunshot wounds differ from other wounds chiefly in the fact that the vitality of the part struck is lost, and that there is a consequent slough or loss of substance. They are dangerous to life on account of their involving vital portions of the body, death occurring either from hemorrhage or from shock to the nervous system. The hemorrhage is seldom great, except when large vessels are wounded. Often, from the form of the wound, there may be but little external bleeding, while a fatal internal hemorrhage may be going on. They differ much in appearance, according to the distance from which the piece was fired, and the nature of the projectiles. If the explosion occurs in close contact with the body, usually less than nineteen inches, the wound is large and circular, the skin denuded, blackened, and burned by the half-consumed grains of powder. The hair and clothes also in the vicinity of the wound are more or less scorched. It may be of vital importance to determine the position in which the revolver was held. The following points will serve if powder-burns are present: The wound of entrance is not in the centre of the powder-burn, there being a very much greater zone of powder-mark at that area of the burn which coincides with the cock or hammer side of the pistol; *e. g.*, if the cock or hammer be upward, the most of the powder-burn will be upward, and whichever meridian of the powder-burn shows the greater

quantity of powder, marks the direction of the cock or hammer. The entrance orifice of the ball is livid and depressed, and is larger than the point of exit. When the piece is fired from a distance, the blackened and burned appearance of the skin is not seen, but only the mark of the entrance of the missile, and sometimes that of the exit. The aperture of entrance of the ball when fired from a distance is, according to most authorities, always smaller than that of exit. Nélaton says that when the wound is recent, the entrance orifice is depressed and contused, while the exit aperture is lacerated and everted. In the former, there is an actual loss of substance ; in the latter, there is merely a solution of continuity. After some days, however, the contused margins of the entrance wound slough away, thereby enlarging the orifice, while those of the exit partially adhere, causing the latter wound to appear smaller than the former. Casper declares that the entrance aperture is always the larger. Very possibly this discrepancy of views may arise from not distinguishing between the early and the later stages of the two orifices. If the ball enters a very fat portion of the body, this often protrudes between the edges of the wound and completely changes its appearance. Again, the character of the entrance will depend very much upon the nature of the projectile and its velocity, as well as the distance from which it was fired. If the ball is conoidal, and traveling with great speed, the wound is linear and resembles a puncture producing little external harm, but causing very considerable external injury. A rifle-ball makes a large and ragged wound, caused by the spiral direction given to the missile. It is evident that several wounds may be made by a single ball, as this may chance to traverse different parts of the body and limbs. It

may also happen that the piece may have been loaded with two or more balls, which may account for the number of the wounds.

The deflection of a ball from its straight or direct course after entering the body is easily produced by its striking obliquely against any resisting surface, such as a bone, tendon, aponeurosis, or even muscle. In this way it often happens that a ball, striking the chest or abdomen, may be caused to pass almost entirely around the body, and afterward be extracted close by the entrance point. Wharton and Stillé relate the case of a wound by a ball striking on the larynx obliquely, and passing around the neck so as to lodge on the opposite side of the thyroid cartilage. It was thence removed by simply cutting through the skin. It is not uncommon for a ball to travel half way around the chest or abdomen and lodge in the back, giving the appearance of having passed directly through the lungs or intestines.

If the wound be caused by a load of shot, its appearance will depend chiefly on the distance from which it was discharged. If fired very near the body, so as to enter it as a single charge before separating, it will produce a single large and ragged wound, much contused and blackened by the powder; and as the shot diverge after entering the body there will be considerable laceration of the parts beneath. For the opening to be single, the experiments of Dr. Lachèse, of Antwerp, indicate that the charge should not be fired at a greater distance than ten to twelve inches, although this is undoubtedly influenced as much by the construction of the barrel and the charge as by distance up to twenty or thirty inches. When the distance is so extended as to allow the scattering of the shot, each grain

will make its own individual wound. It is quite possible for a single shot to cause a mortal wound, as when it happens to strike the heart or aorta.

The newly-invented forms of small arms, most of which throw bullets at very high velocity and are efficient at long range, produce wounds that are somewhat different from those made by the older weapons. Very little experience, except on cadavers, has been as yet gathered upon the subject. It appears, however, that these modern weapons may make cleaner cuts and be less fatal than the older forms.

Wounds made by the wadding and gunpowder alone may prove serious or even fatal. A pistol thus loaded, fired at twelve inches, tore the clothes and abraded the skin without penetrating it; at half this distance the wadding penetrated to the depth of half an inch; at two inches it entered to the depth of two inches, causing a ragged and blackened wound; and at one and a half inches the wadding entered the thorax between the ribs, and in one experiment carried away a portion of the rib. Taylor mentions an instance of a man sitting in the gallery of a theatre, who had part of his hand completely blown away by a piece of greased newspaper, tightly rammed, discharged from a small cannon on the stage of the theatre.

Even gunpowder alone is capable of producing very serious wounds, if fired close to an exposed part of the body. The wound will present a lacerated appearance, and be blackened and burned by the partially consumed powder. If the grain of powder be coarse, the wound may have the appearance of having been caused by very small shot.

The question of the homicidal, suicidal, or accidental character of gunshot wounds must generally be settled by

the appearance of the wounds, and also by the particular circumstances. Thus, if it be on the forehead or temple, behind the ear, in the mouth, or over the heart, and if it be blackened or lacerated (indicating the close proximity of the weapon), it may be regarded as almost certainly a suicidal act. If, on the contrary, the wound be on the back or side of the head (except in the case of the insane), or of the body, without the blackened and lacerated appearance above alluded to, it may be considered as the act of a homicide. Accidental gunshot wounds bear the marks of near wounds, as they are mostly the result of the accidental discharge of the piece, either in the hands of the deceased at the time, or else in close proximity to his person. The possibility of a bullet glancing from a hard surface, and thus entering a point at which the weapon was not aimed, must not be overlooked.

Out of 368 cases of suicide by firearms, in France, 297 were from wounds in the head; of these, 234 were fired into the mouth; only 71 were from wounds inflicted on the chest or abdomen.

In a medico-legal case it may become important to ascertain the real cause of death occasioned by a wound—whether immediate, or from hemorrhage or shock, or remote, resulting from subsequent complications. In a trial, this question might have an important bearing, since, if the cause of the death could be shown to have been remote, this might involve certain contingencies, for which the prisoner might not be responsible.

When the death is directly traceable to hemorrhage, its rapidity depends upon the amount and suddenness of the bleeding; and this again is dependent on the size and nature of the vessel wounded. Exhaustion follows much

more rapidly from a sudden hemorrhage than from a more copious flow of blood, if gradually lost. Again, arterial hemorrhage is more rapidly fatal than venous. It should also be remembered that some persons have a constitutional tendency to bleed very easily from the slightest superficial wound. Such a tendency, termed a hemorrhagic diathesis, is sometimes hereditary, and exposes the individual to great danger, in case of being wounded. This circumstance might also have weight in the trial. Age and disease also increase the danger of death by hemorrhage from wounds.

Internal hemorrhage, as the result of a wound, is often as fatal as the external; the danger is here further increased by the pressure exerted by the effused blood upon a vital organ, such as the brain, as is witnessed in effusion of blood within the cranium, produced by a fracture of the skull. It is also exemplified in a wound of the intercostal arteries, causing effusion of blood into the chest, and producing fatal pressure on the lungs; and also in wounds of the throat, resulting in asphyxia, from the flow of the blood into the windpipe.

Shock is the result of a violent impression made on the nerve centres. It often is the immediate cause of death, after a severe injury, without leaving any trace or lesion discoverable on a post-mortem examination. Shock is most apt to follow extensive lacerations of the body, such as result from machinery or railway accidents, or from extensive burns.

The remote causes of death from wounds are numerous and varied. The following may be regarded as the most common:

1. *Tetanus or Lockjaw.*—This is generally the result of lacerated and punctured wounds, and is now known to

be due to the introduction of a specific bacillus into the tissues. It is always a serious complication, and is mostly fatal. It does not usually appear before the seventh day after the receipt of the wound, though sometimes earlier, and rarely later than the twentieth day.

2. *Erysipelas* is another complication of wounds, which may cause a fatal issue. It is apt to accompany wounds of the scalp; and it sometimes assumes an epidemic character, especially in hospitals, where it may occasion great mortality among the wounded patients.

3. *Hospital gangrene* is another occasional result of wounds. It, likewise, often proves fatal, and may assume an epidemic type. It is, however, rarely seen except in military hospitals.

4. *Surgical Interference, Including the Use of Anesthetics.*—In wounds dangerous to life, the question of the propriety of a surgical operation becomes paramount; the patient will certainly die without the operation, and, on the other hand, he may die from shock as the immediate result of the operation. The question of the legal responsibility of the death then becomes a serious one, and, in a trial, counsel may endeavor to show that the death was not really the result of the wound, but rather owing to the surgical operation. Such an argument will not likely avail, unless it can be proved that the original wound was not of a dangerous character, and that the surgical interference was unwarrantable and unskillful. The same remarks will apply to the use of anesthetics. Their employment in operations has now become so general that the occasional fatal results attending their administration should be regarded as exceptions, in nowise inculpating the attending surgeon; consequently, the fatal result that might happen

to follow their use should not be considered as offering any extenuation if a dangerous or fatal wound has been inflicted. The only medico-legal point a tissue would be—Was the administration of the anesthetic a necessary and proper part of the treatment, and was it skillfully administered?

The question of the responsibility of the surgeon in not employing the antiseptic method will be discussed later, under MALPRACTICE.

It will be proper to devote a brief consideration to the subject of Wounds in different regions of the body, inasmuch as these present certain individual peculiarities, which give to them special medico-legal importance.

Wounds of the Head.—Scalp wounds are not usually attended with danger, except when followed by erysipelas, or when the blow has been so severe as to produce concussion of the brain. Fracture of the skull may exist without any wound of the scalp; and fatal effusion of blood upon the brain may be produced by a blow on the head, without causing either a visible wound of the scalp or a fracture of the skull.

Concussion of the Brain may result either from a direct blow upon the head, or from a violent fall upon the feet or buttocks. Sometimes death ensues immediately from concussion, leaving no perceptible lesion. Such fatal concussion may occur without either fracture of the skull or a wound of the scalp. The symptoms of concussion are faintness, nausea, vomiting, pallor, feeble pulse, partial or complete loss of consciousness, with confusion of ideas and tendency to sleep. Concussion may be confounded with intoxication, compression of the brain, opium poisoning, sunstroke, etc.

It is particularly important to distinguish between concussion and intoxication. Many cases of supposed drunkards, arrested in large cities at night, and left unattended in the station-house till morning, are, in reality, cases of concussion or compression of the brain, which may prove fatal for want of timely relief. Difficulty of diagnosis is increased by the fact that the two conditions are frequently coincident in the same individual. It is the drunken man who is most apt to engage in a brawl, which results in a broken head. Generally, the history of the case (if it can be obtained) and the odor of the breath will afford us the best means of diagnosis. In intoxication, the temperature is usually below 96° F.,—sometimes below 90°; the loss of power and sensation is not unilateral, as in compression; the bladder is generally full of limpid urine, which will furnish evidence of the presence of alcohol. The pupils are sometimes contracted and at other times dilated.

Fracture of the Skull is the result either of a direct blow or a fall upon the head, striking a stone or other hard body. The usual consequence of such a fracture is pressure on the brain by the depressed bone or by extravasated blood. *Fracture of the base of the skull* is nearly always fatal, and unless carefully looked for in the autopsy, may escape notice. It may result from a fall or jump, the person landing on his feet or buttocks, and be, therefore, unattended by any injury of the scalp or face; such cases not uncommonly escape notice in carelessly conducted post-mortems.

Compression of the Brain may result either from effusion of blood or serum upon or within the brain, with or without fracture or depression of the bone; also from suppuration or tumors in the brain, from congestion of the cerebral vessels, and, likewise, from narcotic poisoning. The symp-

toms are essentially those of apoplexy, viz., loss of consciousness, paralysis (usually hemiplegic), dilated pupils (except where the effusion is on the pons Varolii, when, according to Wilks, the pupils are contracted), stertorous breathing, a full, slow pulse, and coma. It is important to remember that the effusion of blood resulting from a blow may be gradual, so that the person seemingly recovers from the first shock, and may be able even to resume his ordinary occupation for some hours, or even days, before the fatal termination occurs. The distinction between the effusion from violence, and that resulting from disease, is, as a rule, that in the former the extravasation is nearly always between the skull and dura mater, or between this membrane and the brain, while in the latter it is usually in the brain substance. Moreover, in the first there is frequently a fracture of the bone and ecchymosis of the scalp, either immediately over the effusion or on the opposite side of the head (counter-stroke).

Another important point is, that a fatal effusion of blood may take place simply from great excitement, especially if associated with intoxication. This may be urged as the probable cause of death where there has been an assault by a blow upon the head which terminated fatally. In such a case it may be difficult to decide how far the fatal effusion was due to natural causes, such as atheroma of the cerebral arteries (which, in a habitual spirit-drinker, might also be connected with a diseased liver and kidneys), or how far it was to be attributable directly to the effects of violence. However, if the assault can be clearly proven, either in connection with a direct blow upon the head, or, indirectly, by a fall upon a stone or other hard body, the mere fact of the preëxisting disease of the arteries or the other organs

should not lead to the view that the violence had no relation to the fatal result; but if the autopsy show that the effused clot, or serum, was of older date than the alleged injury, this would certainly be a strong argument for regarding the death as due to the diseased condition.

Wounds of the substance of the Brain are not always fatal. It is well known that considerable portions of the cerebral substance have escaped through the skull, not only without loss of life, but without serious discernable impairment of the mental powers.

Wounds of the Face are not usually dangerous unless they involve the orbit; a penetrating wound of this part may readily reach the brain, with a fatal result. So, also, a severe blow upon the nose may so injure the ethmoid bone as subsequently to involve the brain.

Wounds of the Neck are attended with much danger, owing to the presence of the large vessels and nerves. In cut throats, the great danger arises from the sudden and profuse hemorrhage. The section of the larynx and trachea is not necessarily fatal, the chief danger arising from suffocation from the flowing back of the blood. A division of the esophagus is almost necessarily fatal, chiefly because of its involving the section of the great vessels of the neck.

Wounds of the Spine are dangerous in proportion to the degree in which the spinal marrow is involved. In concussion of the spine, death sometimes takes place instantly. If the spinal cord be wounded high up, above the region of the phrenic nerve, the function of respiration is immediately arrested, and death ensues. Wherever the injury occurs to the spinal cord, it is understood that there is a complete suspension of the functions of the parts below. In fracture of the vertebræ, the great danger arises from pressure on

the spinal marrow. Sudden death has been produced by the spontaneous luxation of the second cervical vertebra, arising from the fracture of the odontoid process, through disease. Sir Astley Cooper's case was of this character. These fractures have an important medico-legal bearing.

Wounds of the Chest.—The great danger here lies in the hemorrhage from the heart, great vessels, and lungs ; hence, such wounds often prove rapidly fatal. The hemorrhage in wounds of the chest is nearly always internal. Wounds of the lungs, though they may not prove immediately fatal, frequently so terminate after a lapse of time ; this is especially true of gunshot wounds, if the bullet or other foreign substance happens to be retained. *Wounds of the Heart*, if the cavities be penetrated, always terminate fatally and rapidly. Gunshot wounds of the heart do not necessarily cause immediate death ; cases are recorded where the patient survived several months ; after death the ball has been found in the substance of the organ. Even where the cavities of the heart have been perforated by a cutting instrument, there have been instances where the person survived for several days. *Rupture of the heart* may be the result of a violent blow upon the thorax, or it may follow any intense excitement, exertion, or emotion, if this organ happens to be in a diseased condition. Where death has resulted in a brawl in which the deceased received a severe blow on the chest, if the preëxisting disease of the organ can be established, it would be a question how far the violence and how far the disease was to be credited with the result. The case is very similar to the one where death follows a blow upon the head, terminating in compression of the brain, and where a diseased condition of the cerebral vessels existed.

Wounds of the Abdomen.—Even a superficial wound of the abdomen may prove fatal by dividing the epigastric artery. A severe blow upon the epigastric region has frequently produced immediate death, by action upon the solar plexus of nerves. Blows upon any part of the abdomen may be followed by peritoneal inflammation, which often proves fatal. Penetrating or perforating wounds may terminate fatally from the same cause. Wounds of the stomach and intestines, though more satisfactorily treated of late years by the improved antiseptic methods, are dangerous and often fatal, either from hemorrhage or inflammation, or both.

Wounds of the Liver are dangerous, according to their extent and depth. If the gall-bladder is involved, death is apt to ensue in consequence of the peritonitis. The danger from *Wounds of the Kidneys* arises from the effusion of urine, and the consequent inflammation.

In relation to *Wounds of the Bladder*, it should be remembered that this organ may be ruptured spontaneously from over-distention. It is sometimes ruptured by a blow or kick of a horse upon the lower part of the abdomen. In a case of death produced by rupture of the bladder, it might be sought to set up the plea of spontaneous rupture of the organ. Frequently there is no external injury to indicate the true nature of the case, the autopsy alone revealing it, and disclosing, also, extensive peritoneal inflammation, resulting from the escape of urine.

Wounds of the Genital Organs are, in the male, usually self-inflicted, and they are met with most generally among the insane. They comprise castration, more or less complete, and amputation of the penis, partial or entire. The danger to life is great in proportion to the hemorrhage and

injury to the organs. In certain other cases, where the injury has been inflicted by others, and when in a state of erection, the urethra has been found violently torn across, and the corpora cavernosa and spongiosa divided. In females, the chief point of medico-legal interest is to discriminate between wounds of the genitals inflicted by another, and spontaneous hemorrhages from a ruptured vein in the labia. Here, of course, a rigid inspection of the injured parts will be needed.

Examination of Blood Stains.—The identification of blood stains not infrequently constitutes a most important link in the chain of evidence in a trial for homicide. It is a very common practice for a murderer to attribute certain suspicious red stains discovered upon his garments or implements, to spots of red paint, fruit stains, or to the blood of some domestic animal or bird.

To the naked eye blood stains will vary in size, shape, and color. They may be mere films or smears, but generally present the form of distinct spots of different sizes; and if the blood has spurted from an artery obliquely upon a surface, the spots will have assumed a comet-like shape, terminating in a bulbous tail. The color of the stain will depend: (1) Upon its freshness: if recent, it will have a bright red hue; if old, the color will be brownish, or brown red. (2) Upon its thickness; being darker in proportion to the density of the stain. (3) Upon the material on which it has fallen: if the latter is porous, as soft wood, or linen, or cotton fabrics, the tint will be rather dull; but if on polished and hard substances, such as metals, glass, or polished wood, the spots have a darker and shining appearance, and on drying they are apt to crack from the centre, and may thus be easily removed. When dried upon linen or cotton,

they usually have a stiffened feel, like a spot of dried albumin or gum. If the stains be upon a colored substance, they can best be distinguished by artificial light; indeed, they may be entirely invisible in bright daylight. While it is not always possible to even proximate the age of a blood stain, conclusions of great value may be drawn from a careful examination. If a clot or stain has been worn it will be polished, not uncommonly, greasy, and intermixed with dirt. If it is old and unworn, it may be dry and fragile; unless mixed with dirt and grease recent clots are flexible and fracture with difficulty.

We possess several methods of identifying blood stains: (1) the chemical; (2) the microscopic; (3) the spectroscopic. But previously to employing these methods, it will be always proper to examine the suspected spot, if not too much covered with dirt, with a good magnifier; the spot, if a blood stain, will frequently exhibit minute coagula or clots of a shiny hue, intermixed with the fibres of the material on which it is fixed.

1. The Chemical Tests.—Before noticing these, it will be proper to remark briefly on the solubility of the coloring matter of blood. Modern research has shown that the coloring matter of blood (hemoglobin) when quite recent, is very soluble in cold water; but when so old as to have changed to a brown color, it is converted into hematin, which is insoluble in water. This is a fact of considerable importance. For if a garment or other article is washed in cold water immediately after being stained with blood, the blood will probably be discharged so as to leave no trace; but if the garment be kept for some time before the attempt is made to remove the stain by washing, the soluble

hemoglobin will have become more or less associated with the insoluble hematin, and enough of the blood will remain upon the article to suffice for future identification. Hot water will not remove a recent blood stain as effectually as cold water, on account of the action of the heat upon the hemoglobin, changing it into hematin.

If the blood-spot be recent, and there be sufficient material, the examiner should cut out a small piece of the stained fabric, and suspend it by means of a thread in a test-tube containing cold distilled water. In a few minutes the coloring matter will be observed to separate from the material and to descend to the bottom of the water, forming a bright-red solution. If the stain is a little older, more time will be required to effect the solution, which will have a browner hue; and if the stain is very old, there will be no solution whatever.

If the stain be upon a porous substance, such as wood, brick, etc., it should be cut or scraped out, reduced to powder, and then soaked in cold water for some hours and afterward filtered. If the spot be upon a hard metallic surface, as a knife, sword, etc., it should be carefully dried, when it will be apt to crack off; if not, it may be scraped off with a knife. The scraping should be soaked for some time in cold water and filtered. If the solution should not be complete, a little dilute ammonium hydroxid may be added, and, if this should fail, Tidy recommends using a trace of citric acid to effect the solution.

Having procured the clear red solution, the next step is to heat it in a test-tube over a spirit lamp; the following results are thus obtained: (1) the red color disappears; (2) coagulation takes place; (3) a brownish-green precipitate is formed. If there is sufficient quantity of this pre-

cipitate, it may be collected, dried, and heated with a weak ammonium hydroxid solution, which will dissolve it: the solution will appear dark green by reflected and red by transmitted light. (4) Dilute ammonium hydroxid added to the original solution either produces no change of color, or it merely intensifies it; it never changes it to green or crimson, as it does with cochineal and red fruit colors. Tannin gives a red precipitate with the original solution. A solution of chlorin causes no change.

The above tests will suffice to distinguish blood from many red solutions, such as cochineal, kino, madder, logwood, and the various red fruit-juices, none of which coagulate by heat, and all of which are changed in color by the addition of ammonium hydroxid. The stain produced by lemon or orange juice on the blade of a knife, after exposure to the air, may bear some resemblance to an old blood stain; but the tannin test of the solution would immediately detect the difference. So, the stain from red paint (which contains iron) or from iron-mold is easily identified by its solubility in dilute hydrochloric acid, and subsequent indication of iron.

The Guaiacum Test constitutes a beautiful and satisfactory chemical test for blood. It depends upon the following conditions: A freshly-prepared tincture of guaiacum, if dropped into water, precipitates the resin, which, if exposed to the air, gradually acquires a bluish color. If it be exposed to a jar of oxygen gas, the bluing process is more rapid; and if brought in contact with ozone, the blue color is instantly produced. Hence, the bluing must be owing to oxidation. Moreover, while the resin is blued by a variety of mineral and organic substances, the coloring matter o the blood has no effect upon it. The guaiacum test de-

pends, then, upon the fact that while the blood has no power to oxidize or blue the resin, the presence of hydrogen dioxid, which itself has no power to oxidize the guaiacum, causes the resin then to be oxidized by the blood, and the blue color appears. According to Taylor, an excellent way of showing the experiment is to add a few drops of the tincture (freshly prepared from portions of the resin taken from the centre of a lump) to a small quantity of water; this will precipitate the resin. Divide the water suspending the resin into two portions; into one of them pour a little solution of red coloring matter of blood; to the other add a few drops of hydrogen dioxid solution (see below); no change of color is observed in either portion. Now, to the first portion add a few drops of the hydrogen dioxid solution, and to the second a few drops of the red solution; in both cases the sapphire-blue color will soon be seen. In case the solution is turbid from an excess of the resin, the addition of a few drops of alcohol will instantly clear it and bring out the fine blue color distinctly. If the simple addition of the blood solution to the guaiacum produces a blue color, we may be certain that some oxidizing substance is present besides blood, and which conceals its presence. The force of the experiment consists in the fact that blood, of itself, will not blue guaiacum; but in the presence of hydrogen dioxid the blue color is speedily produced.

Care should be taken to use a good quality of hydrogen dioxid solution. There is much sold which is practically worthless.

Objections have been raised against this test on the ground that other substances besides blood will produce a blue color in the presence of guaiacum and hydrogen dioxid, such as saliva, bile, and red wine; but as regards

the two former, their color should at once distinguish them from blood, while the latter substance requires exposure for some hours to produce the same result; whereas, in the case of blood the effect is immediate. This test is as available for old as for fresh blood, for concentrated or diluted blood; hence, for a washed-out blood stain—wherever, in fact, a particle of red coloring matter remains. If no bluing occurs in the presence of the guaiacum and the dioxid, it will be safe to affirm that there is no blood present. With an old blood stain, or one that is too small to afford a sufficient solution, or where there may be some doubt of its presence on a colored material, a very good plan is to moisten the spot first with a few drops of water, then with a sufficient quantity of the guaiacum tincture, and afterward with a few drops of the dioxid, and then press upon it a piece of white tissue or filtering paper; immediately there will appear upon the paper the characteristic blue stain. A number of such impressions may thus be taken from one spot, by simply adding a little more of the guaiacum and the ether, and repeating the pressure upon the paper.

It is known that many substances other than blood will cause the reaction. Among these are compounds containing iron (ferric), copper, manganese, and gold, also glue, casein, and potato skin. It is obvious that many of these substances will not be encountered in actual medico-legal work and with others the interference can be easily avoided. It is also stated that cloth dyed with indigo will simulate blood. The test is not to be relied on by itself. It is an excellent preliminary test. A negative result shows that blood pigment in a soluble form is not present; a positive result will not prove the presence of blood.

Hemin Crystals.—The production of these (known as

Teichmann's test) is proof of the presence of blood, but does not distinguish human from other blood. A small portion of the material to be tested is placed on a microscope slide, a drop of water added, and a minute fragment of sodium chlorid. The slide is then heated to dryness on the steam bath, the residue covered with a cover-glass, and a drop of glacial acetic allowed to run under this. The slide is again heated until bubbles arise under the cover-glass. It is then allowed to cool, when the hemin crystals will form. (E. S. Wood, *Witthaus and Becker*, *Med. Jur. and Tox.*)

It should be observed that the chemical tests will not distinguish arterial from venous blood.

II. The Microscopic Test.—This consists in the identification of the blood corpuscles—especially the red ones—by means of the microscope.

The class of stains adapted for microscopic examination are those in which decomposition has not taken place. If the stain upon the garment has been moist, or submerged in water for a considerable time, decomposition may have led to the dissolution of the corpuscles, and hence interfere with the microscopic examination of the blood. Such materials containing blood will offer the best results to the chemical and spectroscopic methods. Of the other class of stains submitted for examination, they will be either (1) fresh, that is stains which have not dried, and in which the blood may or may not be coagulated, and (2) dry stains, which will be hereafter referred to as "old stains."

In the examination of the fresh stains, it will only be necessary to make a thin spread upon a glass slide and allow it to dry. This is usually best accomplished by

placing the moist blood upon the slide and sweeping the edge of another slide over it, thus scattering the blood in a thin layer, which must be allowed to dry and can be examined at leisure and preserved indefinitely.

For the examination of dried stains, the following reagents and apparatus will be needed :—Chemically clean slides and cover-glasses, an alcohol lamp, a sharp knife of solid metal (so-called antiseptic handle), a microscopic needle, and a small oiler with clean oil. A moist chamber, such as is used in bacteriologic work, may be of use. The reagents will be—

(1st.) Water . . . . . .

(2d.) Potassium hydroxid . 1 part.
Water . . . . . . 2 parts.

(3d.) Müller's fluid :—
Potassium dichromate 1 part.
Sodium sulphate . . 2 parts.
Water . . . . . 100 "

(4th.) Müller's fluid
Glycerol, q. s.
The glycerol is added until a sp. gr. of 1028 is obtained.

(5th.) Glycerol . . . . . . 1 part.
Water . . . . . . 6 parts.

(6th.) Sodium sulphate . . 6 parts.
Water . . . . 8 parts.

The blood stains to be examined will be upon bibulous materials or non-bibulous materials. The first includes clothing, wood (unvarnished or unpainted), carpets, and similar materials. The second includes metallic weapons, buttons, glass, chinaware, highly polished and painted woodwork, etc.

In searching for the stains upon bibulous materials, an ordinary hand glass or a two-inch objective may be used to advantage. The light demanded will depend upon the color and character of the goods, so that it may be necessary to try bright and diffused daylight and artificial light.

The blood spots, when found, may consist of distinct drops, smears, or smudges, and stains which have been influenced by the dilution of the blood, such as by washing the stain or stains which have fallen upon a wet garment, or a garment which has been made wet before coagulation or drying of the blood took place. It is to be remembered that the more rapidly the blood dries, the better it will be preserved, and for this reason the best cells will be obtained from the smaller clots or diffused smudges, or stains which have dried rapidly.

To prepare a slide for examination, the suspected spot in clothing, for example, is bent and laid upon a glass slide, which has previously been breathed upon, in order to make it sufficiently moist to cause the adhesion of the small particles which may fall upon it. The knife blade is then passed through the flame of an alcohol lamp, in order to destroy any organic material which may adhere to it; then the surface of the cloth is gently scraped with the knife blade, until a thin layer of the broken-up stain is distinctly visible to the naked eye upon the slide. A cover-glass is then dropped on this, and one of the above solutions allowed to flow under from the margin until it has dispersed the air from beneath the cover-glass, at least most if not all the air.

The slide may be examined immediately; but, if it is necessary to allow it to soak for any length of time, the evaporation of the fluid may be prevented by running around the margin of the glass a small quantity of oil—ordinary machine oil being applicable for this purpose. The fluid containing glycerol and the potassium hydroxid solution do not, as a rule, require this precaution except in very warm and dry weather, or when the slide is placed in

a moist chamber and allowed to digest. It is better to prepare a series of slides from each stain, using different fluids, because some stains will react differently with different fluids.

The stains on non-bibulous surfaces may be chipped off by means of a knife or small needle, placed upon a slide and broken up, a cover-glass dropped on, and then treated as already described for stains on bibulous materials. Before preparing any slide, and between the examination of any two spots, the knife or needle should be heated in order to destroy any corpuscles which may have adhered from a previous examination. The time necessary for the corpuscles to resolve will vary from a few minutes to twelve hours, in most cases, and rarely be twenty-four or forty-eight hours. During the interval, however, frequent examinations should be made, lest the corpuscles swell up and oval ones become round, and round ones entirely disappear.

In all cases it is proper to make a measurement of the corpuscles, and in order to do this, two micrometers will be needed—one known as the stage micrometer, ruled in $\frac{1}{1000}$ of an inch, and the other an eye piece micrometer, ruled with equidistant parallel lines, usually $\frac{1}{100}$ of an inch apart, although this is not a matter of any great importance, as the eye piece micrometer must be standardized before each observation. To accomplish this the eye piece micrometer should be placed in the eye piece, and the stage micrometer upon the stage of the microscope, and the lens and length of tube so adjusted as to give thirty-two lines of the eye piece micrometer between the lines of $\frac{1}{100}$ of an inch ruling on the stage micrometer, or ten of the $\frac{1}{1000}$ of an inch, which is, of course, equivalent. Artificial

light is best, as it can be regulated. Very accurate measurements can be made by this method.

The blood corpuscles of man and most of the mammals are circular, biconcave disks without nuclei. The exception to this is in the corpuscles of the camel and llama, which are oval but without nucleus. The blood corpuscles of reptiles, birds, and fishes are oval and have a nucleus, with the exception of the lamprey, in which the corpuscles are circular, but nucleated. By reference to the accompanying table, there will be little difficulty in differentiating corpuscles belonging to mammals from those of reptiles, birds, and fishes.

That human corpuscles are altered by some diseases, does not militate against the microscopic examination. There is no disease in which the mammalian characteristics are entirely lost, and in which an expert microscopist would be likely to be misled. In pernicious anemia, leukemia, purpura, yellow fever, and allied diseases, the blood undergoes important changes, but this does not disguise the characteristic appearance of blood corpuscles. It is not deemed necessary to go into any discussion over the question whether the expert can differentiate the blood of a human being from that of other mammals ; sufficient to say that all the expert can consistently do, in the present state of our knowledge, is to say that the blood is mammalian blood, and from his examination and measurements it is consistent with human blood.

Sources of Error.—In making the examination it is to be remembered that solutions of the same specific gravity of the blood, or lighter, will lead to the eventual swelling up and dissolution of the corpuscles, and that from long soaking oval corpuscles may become circular from the

imbibition of water. Certain vegetable structures, notably sporules and some algæ, may resemble blood cells ; but the vegetable cell is not biconcave and has not the translucency of the animal cell, and prolonged soaking does not alter it as it does the blood corpuscle.

The following tables present a synopsis of recent trustworthy measurements of the blood corpuscles of various animals :

COMPARATIVE SIZE OF BLOOD CORPUSCLES.

(The figure is the denominator; the numerator is always unity.)

Animal.	Observer.			Accepted Approximate Measurement.	Appearance of Cell.
	Gulliver.	Wormley.	Formad.		
Man	3200	3250	3200	3200	Biconcave disk without nucleus.
Guinea Pig	3538	3223	3400	3500	" "
Wolf	3600	3422	3450	3600	" "
Dog	3532	3561	3580	3500	" "
Rabbit	3607	3653	3662	3600	" "
Ox	4267	4219	4200	4200	" "
Pig	4230	4268	4250	4200	" "
Horse	4600	4243	4310	4500	" "
Sheep	5300	4912	5000	5000	" "
Goat	6366	6189	6100	6100	" "
Monkey	3412	3382	3400	3400	" "
Kangaroo	3440	3410	3400	3400	" "
Beaver	3325	. .	3325	3300	" "
Seal	3281	. .	3200	3200	" "
Walrus	2769	. .	. .	2700	" "
Elephant	2745	2738	. .	2700	" "
Great Ant-Eater	2769	. .	. .	2700	" "
Capybara	3190	3164	. .	3100	" "
Sloth	2865	. .	. .	2800	" "
Whale	3099	. .	. .	3000	" "
Opossum	3557	3145	. .	3500	" "
Cat	4404	4372	. .	4400	" "
Musk Rat	3550	3282	.	3500	" "
Camel { Long diameter	3361	3201	. .	3300	Oval, biconcave without nucleus.
Camel { Short "	6229	6408	. .	6300	
Chicken { Long diameter	2102	2080	. .	2100	Oval, with nucleus.
Chicken { Short "	3466	3483	. .	3500	
Turkey { Long diameter	2045	1894	. .	2000	" "
Turkey { Short "	3598	3444	. .	3500	

COMPARATIVE SIZE OF BLOOD CORPUSCLES.—(*Continued.*)

(The figure is the denominator; the numerator is always unity.)

Animal.		Observer. Gulliver.	Observer. Wormley.	Observer. Formad.	Accepted Approximate Measurement.	Appearance of Cell.
Pigeon	Long diameter	1973	1892	. .	1900	Oval, with nucleus.
	Short "	3643	3804	.	3700	
Quail .	Long diameter	2347	. .	. .	2300	" "
	Short "	3470	. .	. .	3500	
Dove .	Long diameter	2005	.	. .	2000	" "
	Short "	3369	. .	. .	3300	
Goose .	Long diameter	1836	. .	. .	1800	" "
	Short "	3839	. .	. .	3800	
Duck .	Long diameter	1937	1955	. .	1900	" "
	Short "	3424	3504	. .	3500	
Tortoise (Land)	Long diameter	1252	1250	. .	1200	" "
	Short "	2216	2200	.	2200	
Turtle (Green)	Long diameter	1231	. .	. .	1200	" "
	Short "	1882	. .	. .	1900	
Viper .	Long diameter	1274	. .	. .	1200	" "
	Short "	1800	. .	. .	1800	
Frog .	Long diameter	1108	1089	. .	1100	" "
	Short "	1821	1801	. .	1800	
Toad .	Long diameter	1043	. .	. .	1000	" "
	Short "	2000	. .	. .	2000	
Trout .	Long diameter	1524	.	. .	1500	" "
	Short "	2460	. .	. .	2400	
Perch .	Long diameter	2099	. .	. .	2100	" "
	Short "	2460	. .	. .	2500	
Eel . .	Long diameter	1745	. .	. .	1700	" "
	Short "	2842	.	. .	2800	
Lamprey		2134	. .	. .	2100	Disk with nucleus.
" nucleus of . . .		6400	. .	.	6400	

III. The Optical or Spectroscopic Test.—The application of the spectroscope to the identification of blood depends upon the fact that various colored solutions possess the power of absorbing different portions of the spectrum, producing in the latter certain dark spaces, called *absorption-bands*. Blood produces a very decided effect, even in minute quantities.

When fresh hemoglobin is examined by the spectroscope, it will be seen to produce two absorption-bands of different widths in the green. When hemoglobin is acted upon by acids and alkalies, or kept for a long time, especially in a damp place, it acquires a brown color, becomes deoxidized, and is finally changed into hematin. The spectrum of deoxidized hemoglobin, or of venous blood, shows a single broad absorption-band, visible in the green. After a short exposure to the air it gives a spectrum with the two bands of oxidized hemoglobin much weakened, with a third band visible in the red (methemoglobin). The spectrum of deoxidized hematin, or of blood after prolonged exposure to air, shows two well-defined bands in the green, but stronger than with fresh hemoglobin and with disappearance of the band in the red.

Struve's process for the extraction of blood stains is recommended by Klein. It consists in placing the stained spot in a test-tube and covering it with a small quantity of cold water, through which a slow stream of carbon dioxid is made to pass. If the stain is fresh (within a day), the solution will be complete in about ten minutes; if a month old, about thirty minutes will be required; if two months old, one hour's exposure may be necessary. The clear solution thus obtained is to be examined spectroscopically. In the case of very fresh stains, the two absorption-bands

of oxyhemoglobin are alone visible; but in proportion to the age of the stain, the methemoglobin-band in the red portion becomes more and more decided, and in stains six to eight months old this is the only band visible.

A dilute solution of hydrogen cyanid (1 to 2 drops of a 1 : 1000 solution) has the effect of changing the methemoglobin-band in the red into the two characteristic bands of hemoglobin in the yellow and green portions; whilst solutions of fresh blood stains are apparently unchanged. Hence the action of this reagent may possibly afford a means of determining the age of a given stain.

The form of apparatus best adapted for spectroscopic examination of blood is that suggested by Sorby, to whose researches we are largely indebted for our knowledge in this branch of investigation. It is a combination of the microscope and spectroscope. The micro-spectroscope has the advantage over the ordinary spectroscope in that a comparison prism is inserted, by means of which a fluid of known composition may be compared with the fluid under investigation, the two spectra appearing under the microscope side by side. The fluid prepared for micro-spectroscopic examination is the same as that used for the ordinary spectroscope, which has been previously described. By using cells made from the segments of barometer tubing, a very thick layer of blood, one inch in depth, may be used in the spectroscope, when only four or five drops of the suspected fluid are obtainable.

The important question in this connection is—Do other substances give similar spectra to those of blood? According to Sorby, nothing gives a spectrum precisely similar to that produced by oxyhemoglobin, although certain other bodies produce absorption-lines somewhat resembling the

former, but easily distinguishable by a practiced observer. Thus, the coloring matter of the petals of Cineraria give two absorption-bands; but they are easily distinguished by the action of ammonium hydroxid. Cochineal, madder, and other red dyes, dissolved in alum, although affording bands somewhat resembling those produced by blood, may be distinguished from the latter by the use of ammonium hydroxid and potassium sulphite.

We must, therefore, admit that the spectroscope affords a valuable and delicate test for the presence of blood. It cannot, however, discriminate between human blood and that of any of the lower animals; in this respect, therefore, it is inferior to the microscope, as a test.

BURNS AND SCALDS.

A burn is an injury to the body, caused by heat applied either in the form of a heated solid substance, or by flame, or by radiant heat.

A scald is an injury produced by a heated liquid applied to the body.

Burns and scalds are not, strictly speaking, wounds; though legally they are comprised under the term, bodily injuries. The effects of corrosive liquids, such as sulphuric and other mineral acids, and the strong alkalies, closely resemble burns, and they are so regarded in law. Boiling liquids taken internally may produce internal scalds.

The intensity of a burn is dependent upon the degree of heat applied: it varies from a slight redness to a complete charring of the tissues. Metals heated to redness produce very severe burns, even to the destruction of the flesh; but if in a state of fusion, the injury is yet more serious, in consequence of the partial adhesion of the molten mass to the

skin. Boiling oils produce as decided effects as hot solids or molten metals. Boiling water causes scalds, more or less severe, attended with vesications containing serum; but it never chars or destroys the tissue.

According to Dupuytren, burns may be classified as follows, according to their degree or extent:

(1) Superficial inflammation of the skin, without vesication.

(2) Vesication, or blisters, containing serum, sometimes clear, and sometimes opaque and bloody. If the cuticle be removed, the true skin is very red and granulated, and secretes pus.

(3) Destruction of the external surface of the true skin, forming an eschar, which may be soft and yellow if made by a liquid, or hard and brown or black, if resulting from a solid. The surrounding skin is red and blistered. This form of burns leaves ugly cicatrices, which are white and shining.

(4) Disorganization of the whole skin; these differ from the last only in the deeper destruction of the parts, and in the thickness of the sloughs. The resulting scars are puckered, and depressed below the level of the skin.

(5) The destruction here extends through the skin, and includes the cellular tissue and a portion of the muscles. The general character is the same as in (4).

(6) Complete carbonization of the burnt part, as when a portion of the body is roasted by the fire.

The important medico-legal question to determine is—Was the burn upon the body made before or after death? It is evident that an assassin might murder his victim, and then set fire to the house, hoping thus to escape detection. If a body be found completely charred, it will be impossible

to determine whether it was living or dead when acted upon by the heat; but if the burn be less extensive, it may be possible to form an opinion.

As regards vesications which result from moderately heated solids, or from scalding liquids, if they contain serum their presence, as a rule, indicates that the burn was inflicted during life. The experiments of Christison, Taylor, and Tidy go to show that, although the application of heat to a body within a few minutes after death may sometimes produce a blister, this, however, does not contain serum, but only gas; serous exudation must be regarded as vital. There may be an exception to the above rule in the case of dropsical subjects, in whom it is stated on good authority that serous blisters may be produced after death, by the application of heat. But, on the other hand, the absence of vesication should not be regarded as a proof that the burn was not inflicted during life, since vesication is not always a necessary result of a burn; besides, it is quite possible that only the more serious results may be visible. It is recommended, in all doubtful cases, to examine the cuticle minutely, with a lens, for minute apertures through which the serum may have escaped.

Another sign of burning during life is the presence of a red line around the burn, which gradually merges into the color of the surrounding skin. This red border remains after death, and cannot be produced, according to Christison and Taylor, by the application of heat to the dead body. Tidy's conclusions, based upon a series of his own experiments, are that "when serous blisters are seen on a dead body, the serum being thick and rich in albumin, and the blisters surrounded by a deeply injected red line, the true skin, after the removal of the cuticle, also presenting a

reddened appearance, the evidence is strong that the burn was produced during the life of the person; while it is conclusive that it was caused during the life of the part. But if the blister contains air, the true skin, after the removal of the cuticle, appearing dry and unglazed, of a dull white color, or grayish; or, if the blister contained a little thin, non-albuminous serum, there being in neither case any red surrounding line, nor any injected condition of the cutis vera, the evidence is strong that the burn was inflicted after death."

The danger of burns depends more on their extent than their depth. The reason of this is that extensive burns involve a greater number of sensory nerves, and a greater extent of surface is prevented from performing the function of excretion and heat regulation. Thus, a large superficial scald, especially in young children, is very apt to prove fatal, the symptoms being stupor, somnolence, pallor of face, and feeble pulse, with slow and stertorous breathing—very similar to those of narcotic poisoning, for which, indeed, they have sometimes been mistaken. It has been ascertained that if one-half to two-thirds of the entire skin be involved, the burn will certainly prove fatal; but practically, one involving one-third of the body, if severe, would be very likely to cause death. But here, many circumstances will have to be considered, such as the age, constitution, the part affected, and the character of the burn. Burns are more dangerous in the young; more so on the trunk of the body than on the limbs; and more so if in separate patches than if continuous, provided they are of equal extent. Gunpowder burns are considered more dangerous than those produced by steam.

The Causes of Death from burns are various: as (1)

bodily injury ; as in the case of conflagrations of buildings, where instantaneous death may result from the fall of timbers, walls, etc., or from leaping out of a window, or from a roof. (2) Suffocation, either from the smoke, or from the want of air. (3) Shock ; this is probably the most frequent cause of death after extensive burns. (4) Coma, convulsions, or tetanus. (5) Bronchitis, pneumonia, and other thoracic symptoms. (6) Enteritis and peritonitis. (7) Exhaustion. (8) Gangrene, pyemia, etc.

Post-mortem Appearances.—These are often not well marked, the most constant lesions being a capillary injection of the mucous membrane of the alimentary canal and bronchi, and serous effusion into the ventricles of the brain. In cases where the death has occurred from injury, or from suffocation, the usual lesions would, of course, be discovered after death ; but if the body has been completely charred or roasted, it will probably be impossible to distinguish anything to enable us to form an opinion as to whether the death had preceded the burning or not. The means of identifying the charred remains of a burnt body have already been pointed out.

Wounds upon the Burned.—From the fact that murder is frequently committed and the body subsequently burned by a criminal, with a view of destroying the traces of his crime, it is important for the legal physician always to examine the body for wounds. There are certain mechanical effects produced upon the body by fire which might possibly be mistaken for wounds made before death, such as fissure in the thorax or abdomen, or in the neighborhood of the large joints. These fissures are generally irregular in form ; and as the blood-vessels, by their elasticity, are apt

to escape being torn, these may be seen intact, stretching across the fissure. This appearance is always indicative that the opening was caused by heat, and was not a real wound. A case is mentioned in which two old persons were found burned in their house; the fact of their having been previously stunned, if not killed, by blows on the head, was ascertained by the existence of fractures of the skull, under which coagulated blood was found upon the dura mater. Where the heat has been excessive, the bones of the deceased may be found more or less cracked or split, and sometimes even crumbled to pieces. Ordinary incised, punctured, or contused wounds, made before death, could not be identified in a body completely charred by fire.

As to the question of the burning being accidental, suicidal, or homicidal, it may be assumed that death by burning is nearly always accidental; and such cases are, unfortunately, of frequent occurrence. Death, in such accidental instances, mostly occurs at some distance from the fire, in consequence of the removal of the injured person; although of course it may take place at the time and place of the conflagration. The fact that a dead body is found near the fire may very naturally suggest the idea of accident, since an intoxicated or a deceased person may have caught fire and been unable to move. In all such cases, it is important to examine the body for marks of violence, with the precautions given above. Furthermore, a case might present itself where severe wounds were found on a burnt body, and the question might arise whether the wounds or the fire had been the cause of death. No general rules can be given for guidance in such cases; each one must be determined by the attending circumstances.

The question of Spontaneous Combustion of the human

body presents itself here for a brief notice. It has occasioned considerable discussion in the scientific world for many years past; but although some remarkable instances are related of apparent spontaneous combustion of the human body, originating while alive, on close investigation it will be found that some source of fire had invariably been present, from which the combustion took its origin, such as a lighted pipe or candle, and that the body was that of a habitual spirit-drinker, and nearly always that of a very fat person, conditions highly favorable for the process of combustion when once originated.

From the known composition of the human body—nearly 75 per cent. being water—it would seem to be impossible even to burn it up, except by the application of a high degree of heat, and for a long time, such as is required by the process of cremation. Certainly, the weight of authority is against the belief in spontaneous combustion of the human body; no person of position or authority has ever witnessed such a phenomenon.

It is, of course, an admitted fact that various organic and mineral substances undergo rapid combustion, through the action of oxygen, especially when exposed to the action of the air, in a state of fine powder or extended surface, as in flour-mills and other places where much fine dust is evolved. Conflagrations of large buildings have frequently thus originated, involving important questions as to incendiarism and fire insurance.

DEATH FROM DIFFERENT FORMS OF APNEA (ASPHYXIA).

This includes death from Suffocation, Strangulation, Hanging, and Drowning, in all of which life is destroyed chiefly, if not exclusively, by apnea or asphyxia. All

these modes of violent death possess certain points in common, while, at the same time, each of them is distinguished by individual peculiarities, which render a separate consideration desirable. Their common properties will be first briefly considered.

In all cases of apnea, death begins in the lungs, and this is brought about simply by excluding the air from these organs. This is brought about in various ways: mechanical pressure upon the throat or thorax, as in throttling; by ligature around the throat, as in hanging and strangling; by the flow of water into the windpipe, as in drowning; by foreign bodies getting into the larynx and trachea, as in choking; by being shut up in a box, entombed alive, or buried under ruins, or in a sand bank, or snow drift; or by some disease of the throat, as edema and spasm of the glottis, membranous croup, etc.;—all of which produce death by simply arresting the function of respiration.

Likewise, there are exhibited certain signs or phenomena, both before and after death, which indicate death by apnea. These are lividity of the lips, fingers, and other extremities, and generally of the whole face, together with a swollen appearance of the countenance: convulsive movements of the arms and legs, at first partly voluntary, but soon becoming spasmodic and involuntary, as seen in the struggles to breathe; the veins become turgid; the pulse, at first full and rapid, soon becomes feeble; there is often frothing at the mouth, which may, at times, be tinged with blood from wounding of the tongue; there is frequently turgescence of the genital organs, and involuntary discharges of semen, urine, and feces. Abortive attempts at respiration are made for a while, but finally these cease, and the heart at last ceases to pulsate.

Consciousness is lost very early, although in the earliest stage there may be remarkable activity of the senses. This stage lasts only for a very brief time; such is the testimony of persons who have been rescued from drowning, or who have been cut down from hanging, and of those who have experimented upon themselves by partial strangulation.

This kind of death is rapid, not requiring more than three to five minutes, though there are some apparent exceptions in the case of drowning. These will be referred to hereafter.

The post-mortem appearances in all these varieties of death by apnea are, in the main, very similar. These are lividity of the lips, fingers, and other parts of the body, as seen before death; in drowning, the face is apt to be pale; sometimes, likewise, in hanging. The venous system is generally full of blood. The right side of the heart, together with the lungs, is usually gorged with dark blood; if death has been rapid, post-mortem clots will be found in the heart cavities; if it has been slow, ante-mortem or white clots may be found; the mucous membrane of the bronchial tubes deeply congested. In young persons, the blood-vessels of the lungs will often be found empty, and the lungs emphysematous, from the violent efforts made to respire. Minute extravasations of blood (ecchymoses) are found in the mucous and serous membranes, as the pleura, pericardium, endocardium, peritoneum, etc. The veins and sinuses of the brain are usually turgid with blood, and the brain itself filled with bloody points. The solid viscera, as the liver, spleen, and kidneys, will generally be congested. The blood itself is mostly fluid and dark-colored, except in suffocation from carbon monoxid, when its color is bright red.

Suffocation, properly speaking, includes every variety of death resulting from an impediment to respiration. But as Strangulation, Hanging, and Drowning are considered separately, the term is here restricted to the other modes of death by apnea.

Cases of accidental suffocation are numerous. Infants have thus perished by being too closely wrapped up, or by being overlaid by their mothers. Young children, feeble persons, epileptics, and drunkards have been suffocated by falling into ashes, soft mud, feathers, and similar articles, from which they have been unable to extricate themselves. Mechanical pressure on the thorax, as occurs in vast crowds of people, has destroyed life by suffocation. The accidental slipping into the larynx of small bodies, such as peas, grains of corn, marbles, etc., from the mouth, particularly in children; the lodgment of a piece of meat in the air passages (choking); the detachment of a bronchial gland which becomes impacted in the larynx; the escape of a lumbricus from the stomach, and its entering the larynx; the passing of vomited matters and of blood into the windpipe; various disorders of the throat, as edema and spasm of the glottis, croup, diphtheria, abscess, etc.;—all of these are examples of accidental suffocation.

Suicidal suffocation is extremely rare, though a few remarkable cases are mentioned by authors. In one case—that of a young woman—death was caused by a ball of hay, which she had thrust down the throat into the pharynx, behind the larynx, and which was just visible when the mouth was widely opened.

Homicidal suffocation is usually practiced upon infants, the aged, or those who are otherwise helpless. Suffocation is undoubtedly a very common mode of destroying new-

born children ; it is very easily effected, and may leave behind it no characteristic traces ; death, in such cases, being usually attributed to convulsions. The notorious Edinburgh murderers, Burke and Hare, destroyed their victims by suffocation, forcibly closing the mouth and nostrils of the person, and at the same time bearing their whole weight upon the breast. A curious Scotch case is recorded, in which an intemperate woman, over sixty years of age, was found dead, with a wound upon the scalp, emphysema in the chest, and seven ribs fractured. The face was pale and composed, the eyes closed, and the tongue slightly protruding. On examination, the cork of a quart bottle was found in her larynx, the sealed end being uppermost. The epiglottis, trachea, and larynx were considerably injected. It was attempted, on the trial, to show that the deceased had drawn out the cork with her teeth while she was drunk, but that it was suddenly forced into her windpipe ; this was negatived by the fact that the sealed end of the cork was uppermost, and also by the marks of the corkscrew. It was decided that the cork had been forcibly pushed into her windpipe, when by reason of intoxication she was unable to resist. Another case of homicidal suffocation is that of a Russian sentry, found dead in his watch-box, with a large piece of meat in the lower part of the pharynx, pressing upon and partly in the glottis. His death was, therefore, supposed to be accidental. Some years after his superior officer, in dying, confessed that he had first suffocated the man, and then placed the piece of meat in his throat, in order to divert suspicion from himself.

Post-mortem Appearances.—Lividity and swelling of the face and lips are usual, but in accidental cases the face may

be placid; the eyes are congested; minute ecchymoses appear on the neck and chest; with mucous froth, sometimes bloody, about the mouth and nose; the lungs and right side of the heart may be gorged with dark blood; but in some cases, especially in young children, the lungs may be empty of blood and emphysematous. Hence, the condition of the lungs and heart, as it varies so much, cannot be relied on in a diagnosis. Stress has been laid upon the presence of minute punctiform ecchymoses, especially on the lungs of new-born infants who have been suffocated. These spots are also found on the pleura, lining membrane of the heart, membranes of the brain, peritoneum, and mucous lining of the windpipe, but their value is not universally acknowledged. The blood is dark and very fluid. The kidneys are deeply congested.

As these post-mortem signs are also found in other forms of death by apnea, they cannot be considered as characteristic of death by suffocation. Consequently, the examiner should be cautious in expressing his opinion as to the cause of death. If a dead body be discovered in sand, earth, ashes, or similar substances, the question whether it was placed there before or after death must be decided by a careful examination. If the substances be found in the air passages, and especially in the esophagus and stomach, it may be concluded that the person was alive at the time.

Asphyxia from Gas from Charcoal.—The gases evolved by burning charcoal consist of carbon dioxid and carbon monoxid; the relative proportion of them will depend on the air-supply. If this be abundant, the former gas will be considerably in excess; if imperfect, the latter gas will be

in greater quantity. Charcoal burning in the open air produces but a small amount of monoxid. An atmosphere containing 5 per cent. of carbon dioxid and ½ per cent. of monoxid is said to be fatal to man. There is, however, some uncertainty as to the limit at which carbon dioxid is fatal.

Symptoms and Post-mortem Appearances.—Headache, with a sense of pressure on the temples, vertigo, ringing in the ears, and tendency to sleep, complete loss of muscular power, troubled vision, difficulty of breathing, rapid and feeble pulse, sometimes vomiting, coma, and death, occasionally preceded by convulsions. Death takes place in from one to two hours after exposure; and experience shows that this may occur even when the external air is not completely excluded.

The *post-mortem lesions* vary, depending upon the rapidity of the asphyxia, and the time elapsed between the death and the autopsy. Sometimes the face is injected, the eyes bright and staring, and the limbs supple; again, there is a general pallor of the surface and complete rigidity of the muscles, coming on very soon after death, and disappearing in a few hours. According to Lutaud, the most characteristic sign is the presence of large rosy-colored spots, more or less pronounced, over the thighs, chest, and abdomen. "These rose-colored spots are not seen in any other variety of asphyxia and they remain even after the commencement of putrefaction." The apoplectic nodules in the lungs, and the subpleural ecchymoses, so common in strangulation and suffocation, are rarely seen. There is more or less congestion of the brain. Another important sign is the fluidity and bright redness of the blood. This is owing to the stronger affinity of the hemoglobin for carbon monoxid than for oxy-

gen, in consequence of which the former is retained throughout the circulation. The spectrum furnished by such blood very closely resembles that shown by arterial blood in the spectroscope. This affinity of the hemoglobin for carbon monoxid will satisfactorily explain the presence of the rose-colored spots above alluded to.

In case of death from gases from charcoal, spectroscopic examination of the blood should be made. By this means, Brouardel was enabled to demonstrate the existence of carbon monoxid in the blood of one of the victims of the burning of the Hospital of Saint-Antoine, in 1887. The absorption-lines of carboxy-hemoglobin, that is, blood containing carbon monoxid, are so similar to those of ordinary (oxy) hemoglobin that distinction by observation alone is difficult. The two spectra may be at once distinguished by the fact that the addition of a reducing agent, such as a drop or two of ammonium sulphid to the blood, will produce at once a reduced hemoglobin in the case of normal blood and change the spectrum, while that of carboxy-hemoglobin will not be affected. The extensive introduction of water-gas for illuminating and heating purposes has caused a material increase of cases of carbon monoxid poisoning in American cities. This gas, made by the action of steam upon hot fuel, consists largely of carbon monoxid. Illuminating gas made by the distillation of bituminous coal consists mostly of hydrocarbons, and is far less poisonous. The cases of asphyxia produced by carbon monoxid are not readily amenable to artificial respiration, since the chemical affinity of the gas for the hemoglobin is not overcome by the oxygen.

Slowness of putrefaction is often noticed in cases of death from this form of asphyxia.

Various chemical tests for carboxy-hemoglobin have been proposed, but they are of little value. The spectroscopic test seems to be the best, but even in undoubted cases of poisoning, as where the gas has been directly inhaled with suicidal intent, the results of the examination will sometimes be unsatisfactory.

It may be well to remember that the body of a murdered person may have been so disposed of by an assassin, as to simulate death from charcoal asphyxia; of course all the signs of any such antecedent violence should be carefully sought.

When illuminating gas forms about one-eleventh of the atmosphere, it becomes explosive on contact with a flame. It requires, however, a less proportion than this to render the air incapable of supporting life. The so-called "sewer-gas" explosions are due to the leakage of illuminating gas into sewers and drains. The gases evolved from sewage do not possess the power of forming explosive mixtures.

Many instances of sickness and death may be due to the unconscious breathing of deleterious vapors arising from leakage of gas-pipes, and escape of the gas into the apartments.

The introduction of acetylene as an illuminating and heating agent will doubtless give rise to cases of fatal poisoning, but there are no data yet at hand to permit a satisfactory presentation of the medico-legal relations.

Asphyxia from Emanations of Cesspools. — These contain hydrogen sulphid and ammonium sulphid, together with other sulphur compounds of unknown composition.

The symptoms are a sense of fullness and pain in the head and stomach, vertigo, nausea, sudden loss of muscular

power and of consciousness. There is often an escape of bloody froth from the mouth. The body is cold, the face livid, the pupils dilated and immovable; convulsions and coma usually precede death.

In the examination of cases of asphyxia from the emanations of cesspools or sewers, the expert should seek to isolate the toxic agent (hydrogen sulphid) from the blood.

Strangulation is produced either by pressure upon the neck by means of an encircling cord, or by direct pressure made by the hand on the windpipe, as in throttling. The means by which the constriction is produced are various: sometimes a rope is used, sometimes a strap, a handkerchief, a ribbon, or a strip torn from a sheet or the clothing. In Spain, the usual mode of execution of criminals is by the garrote—a steel collar tightened by a screw; in Turkey it is by the bow string. Death results, in most cases, from the combined effect of the deprivation of atmospheric air, producing apnea, and from congestion of the brain due to the pressure upon the jugulars, preventing a return of blood from the brain. Sudden and violent compression by the hand upon the windpipe will produce unconsciousness sooner than if the constriction be made by a band. Strangulation differs from hanging chiefly in the obliquity of the cord around the neck in the latter, while in strangulation the cord is wound horizontally around the neck. It is important to distinguish between death from strangulation and death from hanging, as the former is nearly always the result of homicide, while the latter is usually suicide. The first question that presents itself is: Was the death caused by strangulation? The appearances of one strangled are usually very distinctly marked: These are livid and swollen

face; staring eyes, with dilated pupils and protruding tongue, which may be bitten; livid extremities; flattened larynx; blood may issue from the nose, mouth, or even ears; the face, neck, chest, and eyes are studded with ecchymoses; the genital organs are frequently turgid; and there may be an escape of urine and feces, as in hanging. Internally, the right heart and venous system are sometimes gorged with blood; but this is less frequent than in other forms of death from apnea; this is also true of the congestion of the liver and kidneys. Tardieu states that the lungs are seldom very full of blood, but he places great reliance upon the emphysematous appearance of these organs, arising from a rupture of the pulmonary vesicles. The sub-pleural ecchymoses, which he regards as characteristic of suffocation, he says, are rare in strangulation. There are also extravasations of blood in the lungs, but none in the brain, whereby it is distinguished from apoplexy, which it resembles in a few of its symptoms.

Among the external signs, the marks of the cord, and of the fingers on the neck, deserve special attention. These are more evident and reliable here than in hanging, because in homicidal strangulation very considerable force is generally employed by the murderer in order to accomplish his object. If the hand has been used, as in throttling, the marks of the fingers will be found upon the front of the throat—sometimes of two or more fingers and the thumb, so that even the particular hand employed may be determined. If a cord has been used the mark will be horizontal, not oblique, as in hanging; sometimes there may be two or three parallel marks, where the cord has been wound around the neck several times. The mark of the cord is apt to be less deep than in hanging, and subcutaneous ex-

travasation is not always found ; but the parts beneath may show considerable infiltration of blood. Fractures of the hyoid bone and of the ossified thyroid cartilage are reported as having occurred. Where great violence has been used to the neck, blood may escape from the mouth and nose. The interior of the larynx and trachea is congested, of a uniform red or violet color, and is coated over with a frothy, bloody mucus, which extends also into the smaller air tubes. This internal discoloration of the windpipe should not be mistaken for the early signs of putrefaction of this organ.

The mark of the cord around the neck may unquestionably be produced on the dead body, if the attempt is made within a few hours after death, and while the body is still warm, but, according to Casper, not after six hours. Therefore, this particular sign should never be relied on to the exclusion of the other characteristic evidences of death by strangulation, such as the livid, swollen countenance, the protruded tongue, the staring eyeballs, etc., none of which are produced by strangulation after death. Hence, although a murderer may place a cord around the neck of his dead victim, with a view to make the case simulate a suicide, there will be little difficulty in detecting the ruse.

Was the strangling accidental, suicidal, or homicidal? Cases of accidental strangulation not infrequently occur. Taylor records two : one of a girl carrying fish in a basket, which was strapped around the upper part of her chest in front. She was found dead, sitting on a stone wall. The basket had probably slipped off while she was resting, and had thus raised the strap, which firmly and fatally compressed the trachea. The other case was that of a boy, whose silk necktie, knotted and tightly twisted around his

neck, was caught in the band of an engine, and his neck drawn down against one of the revolving shafts. He was rescued after his neck had been compressed at least one minute. He became black in the face, and blood escaped from the mouth and ears. For several minutes after the removal of the ligature he was insensible, but ultimately recovered. Another instance is related by Dr. Gordon Smith, of a lad who used to carry a heavy weight suspended from his neck by a string. One day he was found dead, sitting in a chair. He had probably gone to sleep, the weight had slipped, and drawn the cord tight around his neck.

Suicidal strangulation is comparatively rare, except among the insane, with whom it is by no means uncommon. The facility of effecting their purpose by such simple means as a garter, a ribbon, a handkerchief, or a strip torn from a garment, may readily account for such occurrences, and still further, when it is remembered how very rapidly and insidiously unconsciousness steals over the senses under a pressure of the windpipe, thereby taking away from the individual the will and the power to escape. A case mentioned by Taylor will illustrate this. An insane man, with suicidal tendencies, was placed in a private asylum, with special directions to watch him closely to prevent his taking his life. Two attendants were placed over him. These attendants remained at his bedside; but on his requesting them to retire to a little distance, they complied, still keeping a close watch upon him. Two hours afterward, the physician, on visiting the patient, was informed by the attendants that he had been sleeping quietly for some time. On approaching the bed they found, to their surprise, that the man was dead. He had strangled himself simply by tear-

ing off a strip from the bottom of his shirt, rolled it into a cord, and tied it around his neck. Other cases of determined suicides are recorded, in which the cord was found coiled around the neck several times; in one instance, the ligature had been tightened by a stick thrust in and twisted like a tourniquet; and in still another, a sabre had been used for the same purpose.

Homicidal strangulation, as already mentioned, is the most frequent variety of this form of violent death. It is usually recognized by the marks upon the neck and elsewhere, indicating a greater amount of violence employed. Thus, the impression of the ligature on the neck will be deeper and more ecchymosed than occurs in a suicide; it may also be accompanied by the marks of the fingers on the throat, which latter are never found either in a suicidal or accidental case. Besides these, there will frequently be seen contusions, or injuries of other parts of the body, and evidences of a struggle.

It should not be forgotten that the marks of homicidal strangulation may often be discovered many weeks, or even years, after burial. One is mentioned by Wharton and Stillé, where, after thirty-eight days' interment, the evidence of strangulation was obtained chiefly from the striking contrast of the integuments of the neck with those of the rest of the body. There was a white, shriveled space over the larynx, half an inch broad; also a groove around the neck, of a blackish-brown color and parchment-like appearance; this condensed skin was difficult to cut, and its section was perfectly dry and yellowish-white. Another remarkable case occurred in Paris, where the body had been buried several years, and was reduced almost to a perfect skeleton. Several of the cervical vertebræ, together with the right

clavicle, were found held together by a blackish mass, in the composition of which no tissue could be recognized. This mass was surrounded by several twists of a cord two lines in diameter. The cord was much decayed, showing no knots, and its direction was horizontal. The above facts enabled Orfila and others to decide that the woman had perished by strangulation. Another remarkable case is reported in which a body partially burned showed evidence of previous homicidal strangulation in the peculiar horizontal mark encircling the neck, and in the protrusion of the tongue.

The case of the Commonwealth of Pennsylvania *vs.* Cutaire, tried in 1896, in Philadelphia, is interesting in this connection. A carpenter, in repairing a house in the northern part of the city, found a skeleton under the kitchen floor. There were some fragments of clothes and jewelry and a silk handkerchief which had been tied around the neck in a double knot. The bones were promptly identified as those of a woman who had disappeared some fourteen years before. As a result of careful detective work, a man was arrested, tried, and convicted of the murder. He was a boy of about fifteen at the time the woman disappeared. He made a confession declaring that he buried the body, but denied that he killed her. The case has been appealed to the Supreme Court, but at this date (December, 1897) has not been disposed of.

Hanging is that mode of death caused by suspension of the body by the neck, the weight of the body acting as the constricting force. Physiologically, it is the same as strangulation, and, like the latter, the cause of death is partly apnea and partly cerebral congestion, and more frequently a combination of the two.

If the cord encircles the neck below the thyroid cartilage the death is more rapid, and is to be ascribed to apnea; but if higher up, as in executions, where it is apt to slip under the chin, some little space on either side may escape constriction, so as to admit a slight amount of air into the lungs; in this case, the death will be slower, and be due rather to cerebral congestion. In the great majority of cases, however, as shown by the above table, the cause of death is of a mixed nature. In some cases of public executions, in which the fall was very considerable, and in which a violent rotary swing was given to the body of the criminal at the moment of the drop, the odontoid process of the second cervical vertebra has been found either fractured or dislocated, causing immediate death, owing to pressure on the spinal cord. But death, in hanging, from fracture of the vertebra, is far less frequent than is supposed. Orfila states that in the bodies of fifty persons who had been hanged, he met with a fracture of the os hyoides in only one case, while he had never met with a fracture or luxation of the vertebræ.

Unconsciousness very speedily supervenes in hanging, from the circulation of unaërated blood, especially if the trachea is compressed, and death occurs in a very few minutes. Persons who have been cut down after a few minutes' suspension are very rarely resuscitated. And even after an apparent partial recovery, death often follows from secondary effects, especially from congestion of the brain.

The insidious manner in which the loss of consciousness steals upon the brain in hanging deserves especial notice, because it satisfactorily explains the facility with which death takes place, even when the suspension of the body is not complete, but when there has been simply a pressure

of the ligature against the windpipe, the person meanwhile resting on the knees or toes, or being in a semi-recumbent posture.

Post-mortem Appearances.—In the main, they resemble those attending death from strangulation. Externally, swelling and lividity of the face, congestion of the eyelids, dilated pupils, eyes red and protruding, tongue swollen, livid, often protruded, or compressed between the teeth, lower jaw retracted; often a bloody froth escaping from the mouth and nostrils. There are frequently petechial effusions on the neck, shoulders, arms, and hands. In many cases, however, especially in suicides, the countenance is calm, the face pale, the eyes and tongue natural. Sometimes there is turgescence of the genital organs, and an involuntary escape of the urine, feces, and semen; but these signs are by no means peculiar to death by hanging. The position of the head varies according to the part of the neck where the knot was placed. As the latter is usually behind the neck, the head is generally flexed forward. If the knot were in front, the head would be found extended backward (Tardieu). The hands are generally closed, often tightly; the legs extended, and often livid. The neck is nearly always stretched, owing to the weight of the body, and it presents very decided marks of the cord, varying, however, somewhat according to the nature of the latter and its mode of application. Thus, the mark may be deep or superficial, single or double, according to the strain made upon it, and the thickness, roughness, or duplication of the cord. The skin under this mark becomes very dense and tough, and of a yellowish-brown color, and has been aptly compared to old parchment. This appearance is more marked if the body has remained suspended for some hours or days; and the

cellular tissue underneath is also condensed, and has a silvery appearance. Besides the above, there is often a livid mark (ecchymosis), where great violence has been used, as in executions; but the latter is quite distinct from the true mark of the cord, with which it has been confounded. The livid line is much less frequently met with than was formerly supposed.

The groove or furrow in the neck, in the great majority of cases, will be found between the chin and larynx. Lutaud states that it is above the larynx in nearly four-fifths of the cases, and over the larynx in the other fifth. Only twice has it been found below the larynx. Its direction is oblique (which distinguishes it from strangulation); it may also be double (arising from a double fold of the cord), and irregular or interrupted. It is more marked in front, less so at the sides and below the ears, and ceases behind. In general, the narrower the ligature, and the longer the suspension, the deeper the furrow. A broad leather thong, pressing only by its borders, might produce a double mark.

Internally, the appearances usually accompanying asphyxia are met with, such as engorgement of the lungs, right side of the heart, and venous system, with dark fluid blood. Both ventricles of the heart contain blood, if the death has been caused by apoplexy; if by asphyxia, the left cavities are found empty, while the right side of the heart and the large vessels are engorged with blood. The sub-pericardial ecchymoses of Tardieu are not observed. The lining membrane of the larynx and trachea is deeply congested, as in strangulation, and is sometimes coated with a bloody froth, though less so than in strangulation and suffocation. The vessels of the brain are generally congested, but extravasation of blood into the brain or upon its membranes is

extremely rare. The brain itself, when cut into, presents numerous bloody points. The kidneys are usually congested; the stomach frequently presents evidences of such deep congestion as to suggest the idea of an irritant poison. The same is true also of the intestines. Yellowly found coagulated blood on the mucous membrane of the stomach in two out of every five cases of death by hanging.

An exception to the engorgement of the lungs in hanging is recorded by Dr. Wilson, of Birmingham, Ala. The case was that of a negro aged 22 years. The heart ceased beating twelve minutes after the drop fell. The post-mortem, made one hour afterward, showed the lungs to be completely collapsed, though otherwise normal; the pleural cavities entirely free from fluid; right heart distended with dark blood. Stomach deeply congested, and containing a small amount of blood. Liver and kidneys engorged, and brain congested. The above appears to be the second recorded case of collapsed lungs in death from hanging, the other case being that mentioned by Dr. Massey, of Nottingham, England, of an executed criminal, whose lungs were found in a state of extreme collapse.

Among the occasional lesions may be mentioned fracture of the hyoid bone and thyroid cartilage, and rupture of the internal and middle coats of the common carotid artery.

An important question is—Was the death caused by hanging? This cannot always be satisfactorily determined by mere medical evidence, since there are no positive or characteristic signs of this kind of death. The mere suspension of the body is no proof, since a murderer might easily suspend the body of his victim, in order to divert suspicion from the true cause of death. The mark of the cord can be imitated by suspending a dead body by the

neck immediately after death, and, according to Casper, even up to seventy-two hours after, especially if the body be forcibly pulled downward. The livid or ecchymosed line is less likely to be found under these circumstances than the brownish, parchment-like furrow. Hence, it follows that the mark of the cord cannot be regarded as positive evidence of death by hanging; and the other usual signs, such as turgescence and lividity of the face, congested eyes, swollen tongue, etc., are all met with in strangling and other forms of death, while these very signs may be absent in certain cases of hanging. Dr. R. F. Hutchinson states that an invariable sign of death from hanging is the flow of saliva out of the mouth, down the chin, and straight down the chest. The appearance is unmistakable and invariable, and could not occur in a body hung up after death, the secretion of saliva being a living act.

To determine the question whether the hanging was suicidal, homicidal, or accidental, regard must be had to the attending circumstances; remembering always that hanging is a frequent method of suicide. Out of 368 cases of suicide occurring in Berlin, 189 resulted from hanging. Hence, the presumption is always in favor of suicide; besides the difficulties that would attend an attempt at murder by this means. If, however, the body exhibit evidences of great violence externally, denoting a struggle and the presence of several persons, or marks of the fingers about the throat, or of internal laceration, these would be more consistent with homicide. The position of the body will throw very little light upon the question, since it is fully demonstrated that complete suspension is not necessary to produce death. In numerous instances the body has been found, after death, resting upon the knees, the toes, or the

buttocks, or semi-recumbent, and in one case entirely supported by the bedstead, while the neck rested in a loop of leather.

Even if the hands and feet are found tied, the inference is not warranted that the act was homicidal, since determined suicides have been known to perform this very act previous to hanging themselves. Nevertheless, if a person be found with his hands and feet tied, and suspended from a position which obviously he could not have reached himself, the presumption of homicide would certainly be justified.

The age of the deceased might be supposed to assist in solving the question. If a very young person were discovered dead from hanging, it would naturally be attributed to homicide or accident; yet numerous instances have occurred in this country, within the last few years, of suicidal hanging in children not over twelve or fourteen years of age.

Cases of accidental hanging are of occasional occurrence, especially among children, who have, while swinging or otherwise playing, accidentally become entangled in a noose or loop of cord, which was then drawn tightly enough around the neck to strangle them.

Drowning is that special form of death by suffocation in which the breathing is arrested by water, or some other liquid, and even more effectually than by a ligature drawn around the neck. It is not necessary that the whole body should be submerged in order to cause death by drowning. This may be accomplished by merely immersing the face, so as to keep the nose and mouth under the liquid, as is witnessed in the case of drunkards, epileptics, and very young children falling with their faces into very shallow

pools, and perishing from inability to extricate themselves. In drowning, in addition to the usual cause of death by asphyxia—the deprivation of air—there is superadded the physical impediment of the introduction of water into the minute air-tubes and vesicles of the lungs by aspiration, in the violent efforts of the person to breathe. This is demonstrated by the experiments made by the Committee of the Medico-Chirurgical Society of London. Two dogs of the same size were submerged at the same moment, but one had his windpipe plugged, so as to prevent the ingress of both air and water, while the other had not. After two minutes they were taken out together; the one with the windpipe plugged recovered at once on removing the plug; the other died. In three experiments dogs with their windpipes plugged were kept under water four minutes, and recovered perfectly on being taken out. On inspecting the bodies of the animals, the difference was at once manifest. In those that were simply deprived of air by plugging the windpipe, the lungs were congested; but in those that had been submerged in their ordinary condition—*i. e.*, actually drowned—the lungs, besides being congested, exhibited in their bronchial tubes and air vesicles a bloody, frothy mucus, which completely filled the air vesicles and small tubes, forming a mechanical impediment to the ingress or egress of air. The lungs were sodden with water, heavy, soft, and doughy to the feel, and pitted on pressure of the finger. In the lungs of animals that recovered after a short submersion, very little, if any, of this mucous froth was found; its amount was always proportionate to the time of submersion. There is no doubt that this froth is produced by the violent efforts to breathe which are made within a minute after submersion.

Hence, the probability of recovery after drowning is mainly dependent upon the quantity of this mucous froth existing in the air-tubes and vesicles of the lungs, and also of the water that has penetrated into the substance of the lungs. If the quantity is large, the result is almost certainly fatal; if it is small, there is always good hope of recovery. Asphyxia occurs in a minute to a minute and a half after submersion, being occasioned by the circulation of the unaërated blood, though actual death is postponed for a minute or two longer until the heart ceases to beat. If the submersion has been complete for four minutes, the case may be considered hopeless, unless syncope had occurred at the moment of entering the water. This, by partially suspending the attempts at respiration, would undoubtedly tend to prolong life for some minutes longer. Cases are reported of resuscitation after being fifteen minutes under water; but these are exceptional, and were probably cases of syncope, occurring at the moment of submersion. It should be remembered that the heart may continue to beat some minutes after respiration has ceased; but, in the present instance, the pulsation of the heart is no criterion of the power of recovery, on account of the physical impediment in the lungs just alluded to.

Taylor gives the following excellent synopsis of the circumstances attending a case of drowning: "When a person falls into the water and retains his consciousness, violent attempts are made to breathe; at each time that he rises to the surface, a portion of air is received into the lungs; but, owing to the mouth being on a level with the liquid, water also enters and passes into the throat. A quantity of water thus usually enters the mouth, which the drowning person is irresistibly compelled to swallow. In his efforts to breathe

while his head is below the water, a portion of this liquid is drawn into the air-tubes and cells of the lungs. The struggle for life may continue for a longer or shorter period, according to the age, sex, and strength of the person; but the result is that the blood in the lungs is imperfectly aërated, the person becomes exhausted, and insensibility follows. The mouth then sinks altogether below the level of the water; air can no longer enter the lungs; a portion of that which they contained is expelled, and rises in bubbles to the surface; an indescribable feeling of delirium, with a ringing sensation in the ears, supervenes; the person loses all consciousness, and sinks asphyxiated. In the state of asphyxia, while the dark-colored blood is circulating, convulsive movements of the body take place, and the contents of the stomach are sometimes ejected by vomiting. There does not appear to be any sensation of pain; and, as in the other cases of asphyxia, if the person recovers, there is a total unconsciousness of any suffering."

Even after resuscitation from drowning, death frequently takes place within a few hours or days from secondary causes, as exhaustion, obstruction to respiration from the condition of the lungs, convulsions, and spasm of the glottis.

Signs of Death by Drowning.—1. External. These vary, according to the length of time the body has been in the water, and the interval after it was taken out. Supposing the immersion not to have been over two or three hours, and the inspection to be made immediately, the face will be found to be pale, the expression placid, the eyes half open, the eyelids livid, and the pupils dilated, the mouth

half closed or open, the tongue swollen and congested, often indented by the teeth, and perhaps lacerated; the lips and nostrils covered with a mucous froth, which issues from them. The skin is cold and pale, and generally contracted so as to present the appearance called "goose-skin." This, being a vital act, is a pretty sure sign that the body was living when immersed in the water. It is not dependent on cold, as was at one time supposed. Cadaveric rigidity usually comes on early in the drowned, hence the body is often found with the limbs stiffened. Retraction of the penis is considered by Casper and Kanzler as a positive sign of drowning.

Besides the above, there are sometimes seen marks of abrasion on the body, especially on the hands, together with sand, gravel, or mud under the nails, weeds, pieces of wood, or other matters locked in the hands, all of which would seem to indicate that the person had been alive when first immersed in the water; although the abrasions might very possibly have resulted from the body rubbing against some rough substances after death. After several days' immersion, the palms of the hands and soles of the feet become white, thickened, and sodden, the result of imbibition.

If putrefaction has commenced before the body is removed from the water, the face will have assumed a reddish, or bluish-red coloration.

2. *Internal.*—Along with the usual evidences of death from asphyxia (in an early examination) the following signs will be observed: the lungs are distended, overlapping the heart, and are in a flabby condition; this latter is owing to the water taken in by aspiration, during the struggles for breath, which penetrates even the air vesicles, and renders

them sodden and doughy. When cut into, the lungs exude a bloody, mucous froth. The presence of this froth in the smaller tubes and air cells, together with the sodden condition of the lungs, is regarded as one of the most positive signs of death by drowning. Nevertheless, its absence should not be accepted as a proof against drowning, since it has not been found in the bodies of persons who have sunk at once in the water, and never risen to the surface to breathe. Ogston states that in 48.7 per cent. of cases, no water was found in the lungs, and he accounts for its absence by its transudation from the lungs into the pleural cavities, where it was found in quantities varying from one to thirty-four ounces. In a case examined by Dr. Reese a few years ago, the body of a woman taken out of the Delaware, there was an absence of this characteristic froth in the minute bronchial tubes, and also of the peculiar flabby condition of the lungs. The absence of these peculiarities in the lungs of the body of Jennie Cramer, at New Haven, created a feeling in the minds of many that it was not a case of suicide by drowning, but that the girl was murdered before the body was thrown into the water. The discovery of a considerable amount of arsenic in the body of the deceased was sufficient to account for the death. These peculiar conditions of the lungs of the drowned have not yet been sufficiently determined. It is quite possible that some cases of bodies taken out of the water, and reported by coroners' juries as "found drowned," may in reality have met their death by other means, prior to their immersion. It is important to remember that the presence of this mucous froth in the air passages is not seen after putrefaction, nor after long exposure of the body to the air, nor after long immersion. It is also stated to be absent

in those who remained under the water without rising to the surface. These circumstances may account for the fact of its occasional non-observance in the bodies of the drowned. Devergie and other authorities state that this froth is occasionally found in the trachea and bronchi, in deaths from other causes.

Another important indication of death by drowning is the presence of water in the stomach, which had been swallowed in the act of drowning, especially if this corresponds with the water in which the body was found. The value of this is enhanced if, along with the water, there be discovered in the stomach fragments of weeds, sand, mud, or other articles, corresponding with the like substances existing in the pond or river where the drowning occurred. The quantity of water in the stomach varies considerably; it was found to be greater in an animal that was allowed to come to the surface frequently than in one kept completely submerged, because in the latter the power of swallowing was sooner lost, in consequence of the early occurrence of asphyxia.

The absence of water from the stomach is not to be considered as disproving a case of drowning, inasmuch as it is not present (because not swallowed) in cases where either syncope or apoplexy had occurred at the moment of immersion.

The mere discovery of water in the stomach is not of itself a positive indication of death by drowning, since it may have been swallowed before immersion; but with this allowance, and with the restrictions above mentioned, it does constitute a very important sign, inasmuch as it has been ascertained by experiment that water will not penetrate into the stomach after death, unless putrefaction has advanced

to a great extent; consequently, its presence indicates pretty certainly that it had been swallowed in the act of drowning. Orfila's experiments prove that water may penetrate into the larger bronchial tubes after death, but not into the air vesicles of the lungs; besides, in such cases, there is no accompaniment of mucous froth in the air tubes.

The condition of the heart affords no positive indication of death by drowning. In the majority of cases, the right cavities are full, and the left ones empty, as in asphyxia generally; but very often the two sides are equally full.

The brain exhibits no characteristic post-mortem sign. There may be some general fullness of the vessels, but never extravasation of blood, unless a sudden apoplexy had supervened, as when a person plunges suddenly into cold water after eating heartily, or by striking the head against a hard body in the act of diving.

The blood is usually dark and fluid. The fluidity of the blood, according to Brouardel, is owing to the water absorbed into the circulation through the pulmonary tissue; and this is much more decided in cases where the person dies slowly, after coming to the surface frequently, than when, through syncope, apoplexy, or drunkenness, he immediately sinks to the bottom. Brouardel regards the fluidity of the blood, the empty condition of the heart, the infiltration of the lungs with water and froth, and the presence of broad, ill-defined sub-pleural ecchymoses as indicative of gradual drowning with struggling; while, if the blood is not fluid, if there are punctated sub-pleural ecchymoses, and clots of blood in the heart, and rather an absence of pulmonary, watery infiltration, he would consider it a case of drowning in which there had been no

struggles made to breathe. The mucous lining of the stomach and bowels is usually congested and of a deep violet color if the body had been long in the water; this might lead to the suspicion of irritant poisoning, as is seen also in hanging. Occasionally, in cases of drowning, after a full meal, vomiting occurs, and the contents of the stomach are found in the windpipe and lungs; this is a conclusive evidence that the person must have been alive at the time.

The time at which the bodies of the drowned will float varies with the temperature of the air, the water, the age, sex, and corpulence. As the human body is slightly heavier than water, it must remain submerged until it becomes lighter through the development of the gases of putrefaction. Hence, in summer the body may rise within twenty-four hours. In salt water it will float sooner than in fresh; very fat bodies float sooner than lean ones; the bodies of women and those of young children sooner than those of men. Hence, in infanticide by drowning, the infant's body speedily rises to the surface.

To determine the time that has elapsed since the act of drowning, when the body is discovered in the water, is not always possible. After putrefaction has set in, it is mere guesswork. The most certain criteria to guide the examiner are the presence of the mucous froth in the air-tubes and cells, and the presence of water in the lung tissue, both of which indications disappear after exposure to the air and after putrefaction. Hence, the importance of an early inspection. Devergie, who has given particular attention to this subject, offers the following observations: During the winter, for the first three days there is no change. From three to five days there is cadaveric rigidity; the

palms of the hands begin to blanch. From four to eight days the limbs become supple, but still retain their natural color; the palms of the hands are very white. From eight to fifteen days the face, at first pale, becomes red in places and bloated; the skin on the back of the hands and on the feet is blanched; a greenish appearance at the base of the sternum. In one month the skin on hands and feet is very white and in folds, the face reddish-brown, the eyelids and lips greenish, with a reddish-brown patch, surrounded by a greenish zone on the front of the chest. In two months the epidermis of the hands and feet to a great extent is softened and detached, the face generally swollen, and of a brownish color; hair falling out; nails still adherent. In three months, commencing saponification, especially in women, about the face and neck, breasts, groins, and thighs; nails loosened. In four months saponification has progressed on the face, neck, and thighs, and commenced in the brain; general softening and destruction of the hairy parts of the skin.

If the foregoing observations made in the winter were applied to the summer, the following allowances are to be made; five to eight hours' continuance in the water in summer are equivalent to three to five days in winter; twenty-four hours in summer, to four to eight days in winter; four days, to fifteen days; and twelve days, to one month, or six weeks.

If marks of violence be found on the bodies of the drowned, of course suspicion will be aroused of foul play, unless these marks can be satisfactorily attributed to some post-mortem cause. A murderer may destroy his victim, and then throw the body into a river, pond, or well, with the intention to elude suspicion of the real cause of death.

A close examination of the body for wounds and other injuries, together with the absence of the known signs of drowning, will generally enable the examiner to form a correct conclusion. Tardieu regards the presence of sub-pleural ecchymoses, together with sub-pericranial and sub-pericardial effusions, as indicative of a preceding suffocation.

Throwing into rivers or pools is a very common method of disposing of bodies in cases of infanticide.

The question of accident, homicide, or suicide, in the case of drowning, must claim the attention of the legal physician. Homicidal drowning is rare, except in the case of infants. It is denoted by the marks of violence on the body, which cannot be explained by any post-mortem influence. It should be remembered that determined suicides frequently inflict dangerous wounds upon themselves, and then terminate their lives by drowning. Such cases might possibly be mistaken for homicide. The presence of the usual signs of drowning would at least show that the body was alive at the time of immersion. Suicidal and accidental drowning cannot always be distinguished from each other ; inferences may, however, be drawn from the circumstances attending the cases, as the existence of a motive to suicide, or a tendency thereto through melancholia. The proximity of a precipice, or other dangerous place, to the water in which the deceased was found, would naturally suggest accident, especially in the case of a child. The tying of the hands and feet of a person found dead in the water is no proof of homicide, since many instances are recorded of suicides so binding themselves, and of attaching heavy weights, before throwing themselves into the water.

The restoration of the drowned depends chiefly on exciting artificial respiration. The clothes should be immediately

removed, and the body quickly wiped dry and wrapped in a blanket; clear the mouth and nostrils of mucus and water; draw forward the tongue; place the body with the face downward, the forehead resting on one arm, for a few moments, to allow the fluids to run out of the mouth; apply ammonia cautiously to the nose. If respiration is not restored, place the body on the back, with the head raised, and adopt Sylvester's process of artificial respiration, by carrying the arms gently outward and upward above the head for a few seconds: this movement expands the chest. Then lower the arms and bring them to the sides of the chest; by this action expiration is effected. These alternate movements should be made each about every two seconds. All rough handling, such as the vulgar plan of rolling on a barrel, should be avoided. As soon as any signs of respiration are manifested, warmth should be applied to the skin by a warm bath or stimulating friction. When able to swallow, the patient may take a little warm spirit and water, and then be put to bed and allowed to sleep. This treatment has been rewarded with success, after being persisted in for some hours.

DEATH BY ELECTRICITY.

DEATH caused by **Lightning** is often accompanied by results which resemble very strongly the effects of homicidal violence.

The destructive effects of lightning resemble those of a powerful electric battery. In a thunder-storm, the electric condition or polarity of the cloud is different from that of the earth immediately beneath it. When these polarities become intensified by mutual induction, the disruptive discharge ensues through the air, or any other

body that may happen to intervene—the human body, for example.

Experience shows that persons out of doors, especially under trees, are much more liable to be struck by lightning than those within doors.

The fatal effects of lightning are usually instantaneous, death being caused by shock. At times, however, it produces lesions of the brain and spinal cord, such as epilepsy, paralysis, effusion of blood, tetanus, etc., which may subsequently prove fatal. Generally speaking, if death does not follow immediately, or soon after, there may be hopes of recovery.

The visible effects produced by a fatal lightning stroke are remarkably varied. Sometimes, a deep, punctured or lacerated wound will indicate where the fatal blow was struck, upon the head, neck, or other part of the body ; the hair may be singed, or burnt off ; the clothing may be burned or completely stripped off ; the boot may be split open. Again, the course of the electric current may be marked by a deep or superficial burn, extending from the point of entrance, down and around the body, to the ground. If there should happen to be any metallic substances in contact with the body, such as chains, coins, a watch, etc., as these are good conductors of the electric current, it will be certain to include them in the circuit, and they will be frequently found to have been melted.

In other cases of death by lightning, no external wound or burn may be visible. Sometimes there may be severe external injuries, while the clothes entirely escape. Again, the clothing may be completely torn off the body, while the latter exhibits no injury whatever.

The capricious action of the discharge is shown by the

fact that out of a party of three or four sitting under a tree, one or two only may be killed, and the others escape. Again, it has occurred that persons under a *low* tree have been struck, although high trees, and a lightning rod, and an iron bridge were near. Again, the same discharge may produce in one person wounds, and burns in another. The diversity of its action on the clothes may probably be explained by the circumstance of a portion of the clothing being wet, and a portion dry: the former, being a good conductor, might escape the disruption which would be exhibited by the dry portion, which is a bad conductor.

Post-mortem Appearances.—In case of instantaneous death, the body may be found in the exact attitude in which it was struck. Some remarkable instances of this are recorded in the books. In such cases, the rigor mortis occurs immediately after death. Hunter supposed that there was an absence of the usual rigidity after death; but in this he was in error. Coagulation of the blood also occurs, although it is delayed. The face is often bloated and discolored, and putrefaction is usually very rapid. Wounds of various character are observed—contused, lacerated, and punctured; also burns, vesications, and ecchymoses; these latter sometimes exhibit a remarkable arborescent appearance. Occasionally, fractures of the skull and of other bones are noticed. The blood is dark and fluid.

The brain and its membranes generally suffer most severely, the head being usually the first part struck. Congestion of the brain, effusion of blood under the skull and into the ventricles, and even complete disorganization of the brain substance have all been observed. The lungs are sometimes found congested and injured, and the air-tubes full of mucus. The stomach, intestines, liver, and spleen

are also usually much congested. The heart does not exhibit any special alteration.

The medico-legal interest, in cases of death from lightning, is centred in the question of being able to identify such cases, and to distinguish them from those of homicidal violence. A close observation of all the circumstances of the case—such as the occurrence of a thunder-storm about the time of the death, the peculiar appearance of the wounds and burns, especially if the two co-exist on the same body, the half-melted appearance of metallic articles, such as buttons and coins, on the person of the deceased, etc.,—will tend to throw much light upon it.

The introduction of electricity into very general use, in civilized countries, as a source of illumination and as a motor force, has been the occasion of numerous fatal results, arising from the accidental contact of individuals with the detached conducting wires employed. These deaths have sometimes been accompanied with excessive burning of the bodies of the unfortunate victims, at the points of contact of the wires.

Electric currents may be either continuous or alternating. In the former (sometimes called "direct") the current flows constantly in the same direction; in the latter, there are rapid changes in direction, usually more than one hundred a second. Sometimes the electric current is sent in rapid impulses; these are called polyphase currents. It is generally thought that alternating are more dangerous than direct currents of corresponding voltage. Incandescent systems are often run on 110 or 220 volts, and are not sufficient to do serious harm. Trolley-car lines are usually supplied with a continuous current at about 600 volts which is dangerous. Street arc-lamps are almost always supplied

at high pressure, often several thousand volts, and alternating currents are largely used in such installations. These are the most frequent causes of death. In Philadelphia, a man was instantly killed by accidentally touching the end of an umbrella to the lower portion of an arc-lamp.

Subjection to currents of high intensity has been made the means of execution in the State of New York, and has been applied in a number of cases. The absurd term "electrocution," invented by newspaper reporters, has been applied to this method. The prison authorities of New York are apparently satisfied with the system.

It must be borne in mind that while telephone wires do not carry dangerous currents, they may at any time be charged to a fatal extent by contact with wires carrying heavy currents.

DEATH FROM HEAT AND COLD.

The effects of extreme **Heat** on the human system are familiarly witnessed in tropical and semi-tropical climates, during the heated term, in the mortality arising from what is popularly denominated *sunstroke*. In such cases, the dangerous and fatal results are attributable directly to solar heat. But effects equally serious are known to be produced by exposure to artificial heat, if too long continued, as is witnessed in those employed in engine-rooms, factories, etc., where a very high temperature is habitually maintained. There would seem to be, according to the observations of Wood, three distinct conditions of the human body occasioned by excessive heat; in the first (which is rare), we have acute meningitis or phrenitis (sunstroke); in the second, we have heat-exhaustion with collapse, accompanied by a rapid, feeble pulse, a cool, moist skin, and a tendency to

syncope; in the third, we have true thermic fever—that condition which results especially from exposure to artificial heat. But something more than mere heat is required to produce thermic fever. It does not occur in a perfectly pure and dry atmosphere, because the profuse perspiration which is immediately developed by its rapid evaporation keeps the temperature of the body down nearly to the normal standard. If, however, the air is already saturated with moisture, this will prevent the evaporation from the body, and its temperature will rise to a dangerous height.

The symptoms vary in intensity, from a mere headache with drowsiness, to complete insensibility, coma, and paralysis. In many instances, death appears to be caused by paralysis of the heart.

The post-mortem appearances are by no means constant. In some cases (true sunstroke) we find decided congestion of the brain and its membranes, with serum in the ventricles, together with congestion of the lungs and of the abdominal viscera generally, and the heart as in ordinary death from asphyxia. In other cases, there is anemia of the substance of the brain, along with distention of the larger vessels with dark, fluid blood, but the minute vessels empty.

Cases of insolation do not often claim the attention of the legal physician, yet as they might occur remote from witnesses, and with a fatal termination, it is proper that the medical examiner should understand their nature, together with the ordinary accompaniments.

The effects of **Cold** upon the animal body are immediately depressing; but if it be of short duration, and the system is in good health, reaction takes place. The human body has the power to maintain its normal temperature of about 98.6° F. independently of the external temperature. It has

been ascertained by actual experiment that a warm-blooded animal will not survive if its temperature is reduced down 16 to 20 degrees below the normal. There is no authentic account of the recovery of a warm-blooded animal, much less a human being, after the whole body was frozen, although fishes and other of the lower animals are said to have been resuscitated from a frozen state.

Death from cold is hastened by whatever exhausts the system, as fatigue, both bodily and mental, loss of rest, want of proper food and nourishment, mental depression, and particularly intoxication. A damp cold (such as wet clothing) is more dangerous than a dry one. The fatal effects of exposure to cold are witnessed, even in comparatively temperate climates, during the winter, in the cases of the destitute, and especially where this condition is associated with intemperance.

Cases of death from cold do not often require the attention of the medical jurist. There are, however, certain conditions under which they may occur which demand a brief consideration.

Every body in which it is assumed that death has taken place from exposure to cold should be examined as soon as found to determine the proofs of death. Herris records a case in which an infant was removed to an undertaker's establishment, presumably dead; many hours afterward,—the exact time is not given,—when he called to make the autopsy and while in conversation with the undertaker in an adjoining room, their attention was attracted by the crying infant, which by energetic efforts was completely resuscitated.

A not infrequent form of infanticide is the exposure of a new-born child to very cold air. Death will soon ensue

under such circumstances, since the infant's power of resistance to cold is limited. In such a case it will be the physician's duty to examine the body of the child and consider the accompanying circumstances, such as the place where it was found, the temperature of the air, the possibility of its being accidental, etc. As regards the body, he should notice if the pallor is extreme ; if frozen stiff, he should distinguish this rigidity from rigor mortis ; also the arterial color of the blood ; the accumulation of blood on both sides of the heart and in the larger vessels. There may also be marks of violence upon the body.

Occasional instances of the exposure of young children to cold with homicidal intent are recorded. Such a case is related of two inhuman parents causing the death of a daughter, aged eleven years, by compelling her to get out of bed on a very cold night and place herself in a vessel of ice-cold water.

In the treatment of the insane, the barbarous and improper use of the cold shower bath for reducing intractable patients to submission was formerly much more in vogue than at present. It need hardly be said that such treatment is extremely hazardous, and it has been followed by fatal results. Taylor records an instance of a lunatic, aged sixty-five, who was subjected to the cold shower at 45° F., and who afterward took a dose of tartar emetic ; he died in fifteen minutes subsequently. Cases of this character would very properly come under the notice of the legal authorities.

Post-mortem Appearances.—These cannot be considered as very characteristic ; hence, the examiner should be cautious in deciding, in any given case, as to whether exposure to cold was the primary cause of death. All the circumstances of the case here require special consideration, such

as the season of the year, the temperature of the air, the place of exposure, etc. Rigor mortis generally sets in slowly and lasts a long time. According to Ogston, the four following appearances, in the absence of any other obvious cause, would justify the conclusion that the death had resulted from cold, although the signs were not so well marked in children as in adults:

(1) An arterial hue of the blood, except when viewed in mass within the heart; some exceptions are, however, noted.

(2) An unusual accumulation of blood on both sides of the heart.

(3) Pallor of the general surface of the body and congestion of the viscera most largely supplied with blood. In some cases, the congestion of the brain and liver was only moderate.

(4) Irregular and diffused dusky-red patches on limited portions of the exterior of the body, even in non-dependent parts (distinguishing them from suggillations).

As putrefaction does not occur at a freezing temperature, the discovery of a decomposing corpse in the ice or snow would afford very strong, though not absolutely conclusive, evidence that the death was not the result of exposure to cold, but rather that the body had been frozen after death.

DEATH BY STARVATION.

Cases of death by **Starvation** are of sufficiently frequent occurrence to merit the notice of the medical jurist. Acute starvation implies the sudden and complete deprivation of all food. Chronic starvation is the result of a continued deficient supply of food, both in quantity and quality. Homicidal death from acute starvation is very rare; but cases

of accidental death from this cause are sufficiently numerous, as in the instances of miners buried in the earth, shipwrecked mariners, and others cut off from food. Occasionally, prisoners and lunatics will undertake to commit suicide by voluntary abstinence from all food; in the majority of cases, however, courage fails after some days' experience and they give up the attempt.

Many cases of voluntary fasting which have claimed the notice of the public during the past years have proved, on close examination, to be deceptions, food and drink having been supplied surreptitiously to the individuals concerned. Among these instances may be mentioned the case of *Ann Moore*, of Tetbury, England, who was alleged to have abstained from all food from 1807 to 1813. Another case was that of the *Welsh Fasting Girl*, aged thirteen years, who is stated to have absolutely fasted for two years. Both these cases were shown to be impostures. The notorious Dr. Tanner, of our own country, undertook, for a consideration, to perform the feat of a forty days' absolute fast, in New York, in August, 1880, and, to all appearance, he accomplished it. It is stated that during all this time he partook of nothing save some ounces of pure water each day, and that his loss of weight at the end of forty days was thirty-six pounds. The fluctuations in his pulse, temperature, and respiration were unimportant. This case was not under very strict medical supervision, and the doubt as to its genuineness seems to be confirmed by the fact of his voracious feeding on the completion of the fast, unattended by any bad effects, which is contrary to the general experience of others who have been deprived of food for a length of time. Since the above case, several instances are recorded of voluntary fasting for periods varying from

several weeks to some months; but there is nearly always some uncertainty as to absolute fasting.

The following account of a voluntary fast in New York City is taken from *Gaillard's Med. Journal*, December, 1890:

"*Succi's Fast.*—At eight o'clock on the evening of November 5th, Signor Giovanni Succi commenced, in this city, his fast of forty-five days. This person who has undertaken such an extraordinary task is a native of Italy, intelligent, about 36 years old, is 5 feet 4 inches tall, and when he commenced fasting weighed 147¼ pounds, although 3 pounds of this weight was taken on at his last meal. He states that he has already fasted 34 times, for periods ranging from 10 to 40 days, always being under constant surveillance, and at most of these fasts observations were taken by medical men. He also states that he once endured an enforced fast of 60 days while crossing the Nubian desert. Sr. Succi has a liquid, which he calls 'Elixir Medicinale Succi'; this, he claims, is a 'secret,' which was given to him by certain tribes in Africa when he was in that country. He takes 15 to 40 minims of this occasionally, frequently going 4 to 5 days without taking any, and denies that there is any nutriment in it; but says he only takes it to alleviate intestinal pains. A chemical analysis of this liquid shows it to contain morphin hydrochlorid, chloroform, ether, cannabis indica, and alcohol. During all this time he has been most closely watched by three men from the staff of the *New York Herald*, and by medical students, and daily observations have been taken by a committee of physicians, of which one of the associate editors of this journal is a member. Never for an instant has he been from under the eye of one of his watchers, and it has been well

nigh impossible for him to have obtained food. Unlike most fasters, Succi claims to be as strong when he has finished his fast as when he began it, and does not try to husband his strength and energy. He usually goes to bed at midnight, and arises about 9 or 10 A.M. He walks, talks, laughs, smokes, lifts his dumb-bell (16 pounds), and occasionally fences. On the 15th day of fasting he took a horseback ride of 6 or 8 miles. On the 20th day of his fast he had lost about 26 pounds in weight; his temperature, pulse, and respiration had been practically normal for the whole time, his hand-grasp probably slightly increased, and his ability to inflate the spirometer also slightly increased. He has taken from 3 ounces to 38 ounces of water daily, either Croton or Kaiser Brunnen, and has passed from 15 ounces to 24 ounces of urine daily, the specific gravity of which varied from 1017 to 1030, and whose reaction has been acid. Examinations of his urine have shown that there was an increase of the phosphates for the first few days, and since then there has been a gradual decrease. The urea has also decreased, on the whole; but the decrease has been subject to fluctuations. The specific gravity was 1017 the first day, then 1030 for four days, since when it has gradually decreased to 1019. So far his bowels have moved only once, and that movement was about 3 hours after commencing the fast. Measurements of his chest, neck, abdomen, buttocks, thigh, leg, biceps, and forearm all show a perceptible decrease. His face has become paler, thinner, somewhat drawn, and the lines on it have deepened somewhat. His mental condition has remained about the same, except at times, during the last few days, he has not been so cheerful or talkative, and occasionally is somewhat irritable."

After this article had appeared, Succi completed the full

duty, the 45th day of his fast. His total loss of weight slightly exceeded 40 pounds, being a little less than an average of 1 pound per diem. His bodily strength and mental vigor appeared but slightly, if at all, impaired.

Dr. Eisner examined a drop of his blood on the 38th day of his fast, and found it "to be thin and watery, resembling that of a person suffering from long sickness; the corpuscles were very scattered." He further states that the mysterious "Elixir," of which Succi has occasionally partaken, consists of "kola" (an African bean, possessing properties somewhat similar to those of coca), camphor, morphin, and valerian. His temperature, pulse, and respiration, at the termination of the fast, were very nearly normal. After a good night's rest, this remarkable subject partook of an exceptionally good meal with evident relish.

Chronic starvation, as the result of disease, is a frequent cause of death, as is witnessed in stricture of the esophagus, cancer, and other disorders of the stomach and bowels, disease of the pancreas, marasmus, etc. It is likewise the cause of disease and death in young children fed upon unsuitable milk, as when this fluid is deficient in some of its proper constituents. Such cases are abundantly illustrated in the miserable victims of baby-farming. Chronic starvation is also witnessed on a large scale in districts where famine has prevailed, as in certain parts of India, and in the Irish famine of 1847.

The symptoms of chronic starvation are generally well-marked. The sense of hunger is not very urgent; emaciation, especially in the last stage, is extreme; the eyes are hollowed, the pupils dilated; the skin is harsh and dry, and hangs loosely over prominent bones, and, in chronic cases, becomes covered with a brownish, dirty-looking coating, and

exhales an offensive odor, like that of putrefaction. The bowels are either very constipated or the feces are scanty, dry, and dark-colored. There is great muscular debility palpitation, with *tinnitus aurium;* pains in the stomach, with a dry, parched mouth; the intellect sometimes clouded, but again clear to the end, with despondency of mind. The pulse is at first somewhat quickened, afterward it is slower; the temperature is usually below that of health.

Post-mortem Appearances.—Great emaciation of the body, with an almost entire loss of fat; sunken cheeks and eyes. The skin shriveled, and emitting a disagreeable odor. The muscles soft, pale, and wasted. The brain sometimes congested, and at others pale and soft, with effusion of serum on the surface and in the ventricles; the lungs healthy or anemic; the heart more or less contracted and void of blood; stomach and intestines contracted, thin, and transparent; the latter usually empty; the bladder contracted and empty.

As regards the medico-legal relations of starvation, although it is rarely the cause of homicidal death, it should be remembered that the law does not require the absolute deprivation of food to be proved, but only the necessary quantity and quality to be withheld, provided this has been done with an evil intention. Cases of this character are sometimes witnessed in baby-farming.

Death from poisoning will be treated at length in a special section under the title TOXICOLOGY.

CHAPTER VII.

FEIGNED DISEASES.

I. Feigned Bodily Diseases.—These become the subject of inquiry very frequently, especially among soldiers, sailors, and prisoners, who are ever ready to resort to all sorts of pretexts to escape duty, to avoid certain kinds of punishment, or to secure comfortable quarters in a hospital. Among civilians the same fraud is sometimes attempted, as in an alleged incapacity to perform military service, to undergo imprisonment, or to discharge the duties of a juror or witness. Casper remarks: This simulation of disease is sometimes carried out by a purely mental effort, as by cunning, lying, or mimicry; at others, by the aid of materials of various kinds, such as crutches, bandages, trusses, cutting instruments, spectacles, etc. All such cases of pretended disease are termed fictitious by Dr. Ogston. There is another class of cases which are produced by the patient at his convenience, or at least are exaggerations of some trivial complaint; these are named factitious by the above author.

The ingenuity of malingerers is almost incredible. Not only may they resort, when occasion requires, to all manner of disgusting performances, such as swallowing excrement or blood, or other offensive substances, but they may actually maim or injure various organs for the purpose of gaining their object. "The greatest difficulty in detecting imposture arises when we examine the subjective symptoms; and extreme caution is then needed, besides the adoption of

the most delicate tests, which should repeatedly be made use of until we are satisfied as to what is the real condition of the patient." (Hamilton.)

If we may trust chroniclers, simulated diseases were much more common in former times than at present. We rarely now note such extraordinary cases of deception as are described in old books, of persons vomiting frogs and lizards or snakes, passing inky urine, or discharging immense stones from the bladder, etc. Such instances of fraud would soon be detected by the modern means of diagnosis.

It is proper that the physician should understand the reasons or motives of the malingerer for feigning disease, since these may often aid him in unmasking the deception. These motives may be classed under the following heads :—

1. *Fear.*—As, for example, to avoid military service ; or, in the case of the soldier, to be excused from going into battle. According to Beck, the observations of Mr. Lane on the modern Egyptians show that the practice of breaking out one or more teeth, or cutting off a finger, or putting out an eye, was exceedingly common among the young men throughout that country. The same motive influences culprits to escape certain species of punishment which they have deserved, such as flogging or the treadmill.

2. *Gain.*—This is a very prevalent and powerful motive to simulate disease, as, *e. g.*, to obtain damages for some alleged injury, either public or private ; it is often the source of groundless charges in railway accidents ; to procure better quarters, either in a hospital or almshouse ; to obtain a divorce ; to excite commiseration and aid from the benevolent ; and in numerous other methods.

3. *Laziness.*—As in beggars and others, to escape work and live in idleness.

4. *Notoriety.*—This is chiefly witnessed in hysterical women, who will simulate almost every variety of disease, and submit to painful treatment; who will frequently mutilate themselves, and pretend to take poison, or destroy themselves in some other manner, and with no other conceivable motive except to gain notoriety.

As regards the mode of diagnosis, the following general rules may be observed: Cunning and shrewdness must be met by the exercise of these same qualities on the part of the examiner. In nothing are experience and tact of greater assistance to their possessor than in the management of this sort of cases. The examiner should always bear in mind that simulation may be possible, and that this is likely to be practised in a given case if a sufficient motive exists; he should try to discover this motive, using great caution in the attempt.

One should not be content with a single examination of the patient, but should surprise him with an unexpected visit, made soon after the first one, and observe him closely when he is not aware of notice; by this means the deception may often be discovered when he is off his guard.

The patient's account of the rise and progress of his disease should be compared with known medical facts connected with the history of the real disorder. It is often useful to mention in the patient's hearing certain false symptoms of the alleged disease, and afterward ask him after these symptoms; when, if simulating, he will be very apt to enact them just as he heard them. One who complains of a multitude of ailments should always be suspected, especially ailments which have no natural connec-

tion with one another. All local ailments should be examined with the parts uncovered; all dressings and bandages must be removed. The physician should not be misled by cicatrices, cupping scars, leech bites, or blisters. No importance whatever is to be attached to the statements of relatives or friends, since they would naturally sympathize with the patient.

Anesthetics (ether and chloroform) may sometimes be employed successfully in suspected cases of contracture of the spine or muscles. A very successful method is to threaten, and even use, some very repulsive medicine or remedy, as powerful revulsives, and especially the actual cautery; but there are some cases that prove obstinate and unconquerable, even under this severe ordeal.

Special Diagnosis.—*Feigned Pain.*—There is probably no symptom so commonly complained of by the malingerer, and none more difficult to determine by the examiner, than pain, because it is purely a subjective symptom. Hence, it will try the skill and tact of the physician to the utmost. A close and patient investigation will, however, usually detect the fraud. The simulator will either be too exactly correct in his description or else entirely incorrect in his localization. He will exhibit great distress under the slightest pressure, when his attention is directed to the part; but when this is directed elsewhere, no evidence of pain is manifested. Questions or hints, skillfully thrown out, may put him off his guard and reveal the deception. A favorite seat of pain is the back, and it is usual among soldiers to attribute it to rheumatism, contracted by exposure from sleeping on the damp ground. Of course, there are some real sufferers from this cause, but they are outnumbered by

the simulators. The latter may often be detected by close watching when they think they are unobserved. Their agility of motion contrasts wonderfully with their lameness and difficulty of movement when they come into court or before the medical officer for examination.

If the pain complained of is very severe and persistent, and there is an absence of all other concomitant symptoms, there is strong room for suspicion. So, too, if the person complains of intolerable pain in executing certain muscular movements, but evinces no suffering when exercising the same parts in a way more in accordance with his wishes. "A young lady, desirous of escaping her piano practice, complains of pain in one arm and shoulder, and gains the sympathy of her unthinking mother, while the same day she may devote one or two hours to lawn tennis, or use her hands in other ways, and give no report of pain." (Hamilton.) Beck refers to the case of a girl of fifteen years who, in order to be taken away from school, complained of severe neuralgia of the face. On a subsequent occasion, when a recurrence of the pain was complained of for some similar motive, Thompson very successfully employed a strong mental remedy, based upon the known antipathy she had to a dog. He informed her that the only remedy remaining was to rub the affected part over the back of that animal. The result was a complete and immediate cure, without the application of the remedy.

But, admitting the frequency of malingering in the case of pain, the examiner should, on the other hand, avoid the risk of making a too hasty diagnosis, since there may be cases of real occult disease accompanied by pain, and where the latter symptom may be wrongfully attributed to imposture.

Fever, especially of the intermittent and ephemeral types, may sometimes be cleverly imitated. The heat of skin and excitement of pulse have been produced by the use of stimulants, as spirits, cantharides, etc., and by friction on the skin; the coating of the tongue, by the use of chalk, pipe clay, liquorice, etc. Dr. Cheyne was sent for to a soldier who was said to be in the chill of an intermittent. He found him shaking violently, but, on throwing off the bed-clothes, he was seen, not in the cold, but in the sweating stage, produced by his exertions.

Pretended Heart-disease.—Extreme feebleness of the pulse has been produced by ligatures around the arm, by pressure upon the axillary artery, and, in certain individuals, by taking a deep inspiration and suspending the breathing. The case of Col. Townshend, reported by Cheyne, was of a similar character, where there was a voluntary suspension of the heart's action for a limited period. Palpitation may be excited by the internal use of various drugs, as tobacco, digitalis, and American hellebore; also by introducing these substances into the rectum. The stethoscope should be used in all suspected cases.

Feigned Pulmonary Tuberculosis.—This disease has been simulated by coughing and by producing emaciation by abstinence and the use of vinegar; by pricking the gums or fauces and spitting up blood; by mixing the sputa of ordinary catarrh with pus and blood, etc. A careful stethoscopic examination will usually detect the imposture; but the examination of the sputa for the specific bacillus will be the most satisfactory test. Foreign blood may also be discovered by the microscope. Hematemesis has been imitated by the patient swallowing blood and then throwing it up in the presence of spectators. Casper mentions a case of a

woman who exhibited a bloody handkerchief as an evidence of her having vomited blood, but which, on microscopic examination, proved to be the blood of a bird. Hematuria has been feigned by mixing blood with the urine or by using substances that have the power of reddening this secretion. The suspected patient should always be made to urinate in the presence of the examiner, and the urine be properly examined for blood.

Feigned Incontinence of Urine.—This is frequently practised by soldiers in order to get into a hospital. A good plan to detect the imposture is to give an opiate at night, and introduce the catheter during his sleep; or by taking him by surprise during the day, and introducing the instrument, when it will be found that the urine has not drained off drop by drop as it was secreted, but that the bladder possesses the power of retention. If the disease is real, the prepuce and glans penis are found to be pale, from its continuance, and always moist; and the clothes exale a urinous odor.

Feigned Epilepsy.—This disease is very frequently simulated, probably for the reason of the pity and affright that it is apt to inspire; and also on account of the short duration of the paroxysm and the length of the interval during which the patient may enjoy his liberty. Impostors affect the most violent forms of the disorder, suddenly falling down in convenient places, and writhing in great contortions; they thus are apt to overdo it. Many cases may be unmasked by threats, or by applying a strong faradic current, or the actual cautery. But instances are related where the impostor has suffered all manner of injury rather than confess, and the noted Clegg, "the dummy clincher," threw

himself, in one of his pretended paroxysms, from a corridor to the floor, a distance of nearly twenty feet.

Sometimes the impostor will produce frothing at the mouth by inserting a piece of soap behind the cheek. In suspected cases it is, therefore, well to examine the mouth. If closely watched, the malingerer may be observed to look about him, or to show some interest in the result of his actions. In real epilepsy, there is an entire loss of consciousness, and also of sensation to the severest applications. DeHaen relates the case of a beggar in Paris, who often fell in the streets. A bed of straw was prepared, through compassion, on which he might be laid, to prevent injury to himself. When next attacked, he was laid on it, and the four corners set on fire. He sprang up and fled.

The best plan is for the examiner to be fully acquainted with the phenomena and signs of the genuine disease, so as to be able to compare them with the feigned. In true epilepsy the patient falls forward, and as he falls he is very pale; during the convulsion, the features are turgid and livid; the veins of the neck swollen; the pupils dilated and insensible to light; the hands clenched, with the thumbs closed within the hands. If the hands be forced open, they remain relaxed, whereas in the feigned, they immediately close again. The muscular rigidity is simultaneous over the whole body; nor is there any regular period for the return of the fits. Thus, a simulated case was detected by the surgeon stating in his hearing that the real disease always came on in the morning; he swallowed the bait, and the subsequent attacks always occurred before noon. In the real disease, the sense of smell is entirely abolished. Occasionally there may be hemiplegia. The urine, feces,

and semen may often be discharged during the paroxysm. Ecchymoses are sometimes found on the shoulders after a fit; and bruises and other injuries may sometimes be met with, as results of the fall.

Beck mentions another fact that should be remembered, namely, that the real epileptic is desirous of concealing his situation, through a sort of false shame, whilst the pretender talks about the disease, and apparently delights in publicity. In the feigned, the glottis is not closed, and respiration, though impeded, is not interrupted; nor does the face become so swollen or livid as in the real.

Feigned Paralysis.—This disease is frequently simulated, usually in a single limb, but sometimes in both the upper or the lower extremities. In such cases it will be found that there is usually more or less rigidity; that there is no atrophy, as in the real, and that the electric currents will produce their usual reactions. The sensation and reflex movements, moreover, are not lost.

One of the most efficient means of detecting the impostor is to administer a severe electric shock. Suddenly and unexpectedly seizing the paralyzed limb will sometimes discover the fraud, by the patient exerting his strength to prevent the raising of the limb.

Hutchinson administered to one who pretended to have paralysis of his right arm a large dose of laudanum secretly, in his tea, and when he was sound asleep he tickled his right ear with a feather, when instantly the lame hand was raised. In some cases the pretence may be unmasked by the use of anesthetics; and in one of paralysis of the legs reported by Marshall, after every attempt to discover the fraud had failed, it was finally brought out by rubbing

cowhage (*Dolichos pruriens*) on the soles of the feet, at bed-time. He walked and groaned all night, and the next morning reported himself fit for duty.

Feigned Unconsciousness, Trance, Catalepsy, and Somnambulism.—These different nervous conditions may all be simulated, where there is sufficient motive; but careful watching and study of the cases will usually succeed in detecting the imposture.

One of the most remarkable cases of feigned unconsciousness is that of Phineas Adams. This man was a soldier and was imprisoned for desertion. He remained apparently unconscious for over two months, in spite of the most powerful applications in the form of revulsives, even to the cutting down through the scalp upon the skull. As his case was considered hopeless he was discharged, and in a couple of days he was seen perfectly restored, and assisting his father in thatching a rick.

Feigned Diseases of the Eye.—Ophthalmia is artificially produced by the introduction of irritants into the eye. It is, however, detected by the rapidity of its progress, arriving at its height within a few hours after the application of the irritant. In soldiers, sometimes only one eye is affected, and almost uniformly the right one—the one with which he takes aim. A left-handed man would probably inflict the injury on the left eye.

It is sometimes difficult to detect cases of blindness arising from amaurosis. In this disease the pupil is usually dilated and fixed, but there are instances in which it retains some contractile power. The patient should be carefully watched to see whether he avoids obstacles placed in his way. If the pupil contracts perfectly, there is no doubt

about the case being feigned. The dilated, immovable pupil may be imitated by the use of belladonna or other mydriatics.

Feigned Deafness may often be detected by making a noise at an unexpected moment, such as dropping a piece of metal; he will be very apt to turn his head in the direction from whence the noise proceeded. The suspected person should be taken unawares, the tone of the examiner's voice should be changed; his countenance should be watched while something in which he is personally interested is being related to him. A deaf person usually converses in a low tone of voice.

Dunlap mentions the case of a soldier who pretended deafness so well that firing a pistol at his ear produced no effect; but on trying the experiment after he had been put to sleep by opium, he started up out of bed.

Pretended Deaf-mutism is more difficult to maintain than pretended deafness. The best plan, in order to detect the imposture, is to say something that deeply interests the patient, and watch the physiognomy. Notice also if a body let fall near the person will, by its vibrations, cause him to look around. The application of a strong faradic current over the larynx will sometimes succeed in detecting the fraud.

The case of Victor Travanait illustrates the ingenuity and perseverance of some of these cases. This young man succeeded for four years in eluding the closest scrutiny exercised upon him throughout Europe; he was, however, at last discovered by the celebrated Sicard, of Paris.

Fictitious Tumors and Enlargements.—These are generally feigned by impostors for the purpose of exciting sympathy and material aid. Hydrocephalus in children, and local

dropsy in both children and adults, are simulated by blowing up the cellular tissues under the skin, and by ligatures on various parts of the body. Mahon relates the case of a young woman of Strasburg, whose abdomen commenced to swell, and continued to do so for thirty-nine years, by which means she excited the commiseration and charity of all who saw her, and by which she procured a comfortable support. At her death, in place of the supposed tumor, there was found merely an enormous sack or cushion, which she had habitually worn over her abdomen. She never would consent to a medical examination for obvious reasons.

Pretended or Factitious Wounds, or voluntary mutilations, are inflicted for various purposes, as for attracting sympathy, or cloaking some criminal act that may have been committed. Mutilation of the thumb was common among the conscripts of ancient Rome, and it is stated to be quite a common practice among soldiers, during modern wars, to inflict similar injuries upon themselves, either by fire-arms or by cutting instruments.

The case of Whittaker, the colored West Point cadet, affords an illustration of self-inflicted wounds, along with an affected unconsciousness, for the purpose of carrying out a certain scheme. This youth had repeatedly failed in his studies; and upon the eve of his examination, which would most probably have resulted in his suspension, he made a desperate attempt to excite the sympathy of the community, as well as to gain time for study. One morning he was found in his sleeping room, apparently unconscious, and tied to his bed with strips of muslin. There were several slight cuts, one on the ear and another across the toe. He continued apparently unconscious of all surroundings for

some time, when he opened his eyes in a stupid condition. His story was that he had been surprised several hours before by a band of masked men, who felled him to the floor, and who, after wounding and threatening him, left the room. Numerous circumstances showed that the whole thing was an imposture, and on trial he was found guilty, but his sentence was modified.

Another case was that of a bank cashier, who was found gagged and tied, and wounded in a superficial manner, while at the same time the funds of the bank were missing. It was afterward discovered that the wounds were self-inflicted, and that other preparations were made for the purpose of diverting suspicion from himself.

In cases of this character, one very suspicious circumstance is that the wounds are always superficial, and not of a dangerous character; they are usually mere cuts or scratches, not involving any vital parts. Moreover, the cuts or stabs made in the garments will often be found not to correspond with those made on the body. It sometimes happens that slight and trivial injuries received in a railway or other collision are magnified purposely, in order to obtain larger damages in a suit at law. Again, persons who have unsuccessfully attempted to commit suicide are apt, from motives of shame or disappointment, to attribute their wounds to another. In such cases, the injuries are superficial, made usually by the right hand and in front, while the hands themselves are seldom wounded; in a real assault the hands are very apt to be cut and maimed.

Feigned Pregnancy and Delivery will be hereafter considered.

II. Feigned Mental Disorders will be discussed under the head of INSANITY.

CHAPTER VIII.

PREGNANCY.

THE occasions in which **Pregnancy** becomes the subject of medico-legal inquiry are the following: (1) A woman may declare herself pregnant with an heir to an estate, for the purpose of defrauding other heirs-at-law; (2) for the purpose of extorting money from a seducer or paramour; (3) to stay the infliction of capital punishment until after delivery; (4) the plea of pregnancy may be set up as an excuse for non-attendance at a trial to awaken sympathy, etc.; (5) an accusation of pregnancy may be made against a single woman, or one living apart from her husband, which may result in an action for damages for slander; (6) accusations of malpractice may be made against a medical man for error in diagnosis of pregnancy, or an attempt to bring on an abortion.

On the other hand, pregnancy may be concealed (1) in order to procure abortion or infanticide; (2) in order to avoid disgrace.

The Roman law exempted a pregnant female from capital punishment until after delivery. The laws of most modern countries follow the Roman custom in this matter. By the old English law, under the writ of *de ventre inspiciendo*, "a jury of twelve matrons, or discrete women," was summoned to ascertain the fact of pregnancy in the civil case, and the further fact of the woman's being "quick with child," in a criminal accusation. In Scotland, the pregnancy simply must be proved without reference to quicken-

ing, and without the jury of matrons. At the present day, both in England and in our own country, the jury of matrons has been very properly superseded by a jury of instructed physicians.

To enable the physician to decide upon the fact of pregnancy, he must necessarily be acquainted with its *signs*. These may be described under the heads of (1) the uncertain and (2) the certain, or positive, signs.

I. *Uncertain Signs.*—These comprise the following:

(*a*) *Suppression of the Catamenia.*—This may be regarded as a probable sign of pregnancy if it occurs in a woman who was always regular, and if at the end of three months she recovers her usual health without re-establishment of the function; since, if the suppression were the result of disease, a general and continued loss of health would be apt to follow. But there are many exceptions,—as when the menses are suppressed, temporarily, by disease; when menstruation continues throughout pregnancy; when it has never occurred in the woman at all, and yet she has given birth to several children and continued in good health; and when the catamenia have appeared only during pregnancy, but were absent at other times.

In cases of concealed pregnancy, the woman may stain her linen with blood (and even with borrowed menstrual blood) for the purpose of imitating menstruation. This deception may generally be detected by close watching, and still more accurately by a microscopic examination of the suspected stains. Menstrual blood does not coagulate so readily as ordinary human blood, on account of the vaginal mucus. It also contains epithelium scales, easily recognized by the microscope.

(*b*) *Morning Sickness.*—Nausea is very apt to be an early

accompaniment of pregnancy, sometimes as early as the second or third week after conception. It usually ceases after quickening, but it may continue throughout the whole period as a most distressing symptom. There are many cases, however, where it does not occur; and it is also an uncertain sign of pregnancy, because nausea accompanies many diseases.

(*c*) *Enlargement of the Abdomen.*—In pregnancy, the enlargement of the abdomen begins to be obvious after the end of the third month, when the uterus rises out of the cavity of the pelvis. At about the fifth month, it is midway between the pelvis and umbilicus, which latter it reaches at the end of the sixth month. During the seventh month, it reaches half way between the umbilicus and the ensiform cartilage; at the end of the eighth month, it is on a level with this cartilage. During the ninth month, it does not ascend higher, but the tumor widens somewhat and falls slightly forward.

This sign is subject to many fallacies: the enlargement may proceed from ascites, ovarian dropsy, ovarian tumor, retained catamenia, flatus of the intestines, impacted feces, excess of fat, distention of the bladder, and enlargement of spleen and kidney. Great caution is necessary in order to make a diagnosis; mistakes have been make even by experienced examiners. Intestinal flatus may be distinguished by percussion; the presence of fluid (ascites and ovarian dropsy), by palpitation; ovarian enlargement, by its history and progress. In true pregnancy, after the seventh month, the tumor will sensibly contract under the cold hand, and the fetal movements may be distinctly felt. The outlines of the fetus also can often be felt. A dark line extending from the umbilicus to the pubis may also generally be dis-

tinguished; but this may date from a previous pregnancy, and also may accompany ovarian enlargement.

The enlargement of the abdomen may lead to unfounded suspicions reflecting upon the reputation and happiness of the female. In certain puzzling cases, in which the enlargement is accompanied by subjective signs on the part of the woman, simulating the movements of the child, it may be traced to accumulation of flatus in the intestines, accompanied by contraction of the abdominal muscles, constituting a phantom tumor; this condition is best cleared up by placing the woman under ether, when the enlargement will be found to subside.

(*d*) *Quickening.*—By this term is understood the first perception by the mother of the movements of the fetus. Its usual time of occurrence is from about the sixteenth to the twenty-fourth week—sometimes earlier, sometimes later. It may often be absent altogether, even when a healthy child is born. Its cause is ascribed either to the rising of the uterus out of the cavity of the pelvis, or to the increased activity of the fetus, or to the latter now coming in contact with the uterine walls. However produced, it is a very deceptive sign of pregnancy, as it is purely a subjective symptom, and many nervous women, especially when anxious to have children, will mistake movements of the intestines and the contraction of the abdominal muscles for the motions of a child.

(*e*) *Development of the Breasts.*—As a general rule, during the progress of pregnancy, the breasts become larger, fuller, more knotty, and tender to the touch; enlarged veins course along the surface; the nipples and the surrounding follicles become more prominent; the areola widens and assumes a darker hue, especially observable in brunettes. In fair

women, these changes are often not noticeable. Besides, enlargement of the breasts often occurs in suppression of the menses, in uterine fibroids, and in ovarian and uterine disorders. An excessive adipose secretion around the breasts is liable to be confounded with a true enlargement of the mammary gland.

The increased development of the breasts, being due to the secretion of milk, is more observable towards the end of the pregnancy, when, frequently, this secretion is manifested.

The presence of milk in the mammary gland is no proof of pregnancy, since it has frequently been seen in the unimpregnated female, and even in young girls. Dr. E. Warren, of North Carolina, relates an instance of a woman, aged fifty-five years, whose catamenia had ceased, and who was in poor health, when she undertook to bring up the child of a deceased friend. To keep it quiet at night, she was accustomed to put it to the breast. In six months the secretion of milk was perfectly established, and she continued to nurse it for twelve months, the child becoming healthy and strong. Still more remarkable are the cases of secretion in the breasts of males. Dunglison relates the case of a man aged fifty-five years, who performed the office of wet nurse for several years.

(*f*) *The violet color of the vagina*, due to venous congestion (Jacquemin's test), commencing about the fourth week. This is considered, by Montgomery and others, as a very certain sign of pregnancy, though its absence is not to be accepted as a negative proof. Dr. R. Barnes regards the flattening of the upper wall of the vagina as a reliable sign of pregnancy in the early months. It is attributed to the enlargement of the womb with slight anteversion, throwing

the os backward, and rendering the superior wall of the vagina tense.

II. *Certain, or positive, signs*:—

(*a*) *Ballottement.*—This test will determine the presence of a fetus (or some floating body) in the liquor amnii, as early as the fifth or sixth month of pregnancy. It is practised by causing the woman to stand upright, and introducing a finger into the vagina up to the mouth of the womb, while the other hand is placed over the abdomen, so as to steady the uterine tumor. If the tip of the finger is now suddenly jerked upward against the os, a sensation will be imparted to it as from a body floating upward in a liquid, and falling back again to strike the finger. It is stated that floating tumors of the uterus, attached to its walls by a pellicle, may produce the same sensation to the finger.

(*b*) *Change in the Body and Cervix of the Uterus.*—The shortening of the cervix is perceptible to the touch after the fifth month; the os uteri is directed more backward, and there is a peculiar velvety feel about it. The neck continues to shorten until the ninth month, when it becomes obliterated, having been absorbed into the body of the womb. The feel of the os in the unimpregnated and in the pregnant state is different; in the latter, it is more patulous than in the former..

(*c*) *The Active Motions of the Child.*—These can rarely be distinguished before the fifth month, after which they usually increase in strength, progressively. They are manifested by placing the cold hand upon the surface of the abdomen. These movements should not be confounded with intestinal movements caused by the escape of flatus from one portion of the bowels into another. Cases often occur in which the active motions of the child are scarcely perceptible.

(*d*) *Pulsation of the Fetal Heart.*—This is an unequivocal proof of pregnancy, when it can be positively and repeatedly determined. The sound resembles the ticking of a watch; it is a double sound, not synchronous with the mother's pulse, and counting from 150 to 120 a minute, according as pregnancy advances. It is heard over different parts of the abdomen, but preferably between the ilium and the umbilicus, on either side. At times it may be inaudible, owing to a change in the position of the child. This sound may often be heard as early as the fifth month, but it becomes more distinct as pregnancy advances.

(*e*) *Other Fetal Sounds.*—These are the Uterine and Umbilical Souffle. The first is a peculiar blowing or whistling sound, audible over most of the abdomen, and believed to be due to the passage of the blood through the uterine arteries, or the placental vessels. It is synchronous with the pulse of the mother. It can be perceived as early as the tenth week, but better at a later period, up to the end of the seventh month. It is not an important sign of pregnancy, inasmuch as it may be heard in enlargement of the uterus from any cause, as by tumors, etc.

The second or Umbilical sound is attributed to the circulation through the umbilical vessels. It is more difficult to distinguish than the other sound, and is of little diagnostic importance. It is a single bellows murmur, synchronous with the pulsations of the fetal heart, and is heard over a very limited space, and is best distinguished in cases where the cord is wound round the body of the child. With all the above signs at command, it is safer not to give a positive opinion in a case of suspected pregnancy before the sixth month.

The Corpus Luteum.—The value of the corpus luteum

or the stellated cicatrix, as a diagnostic sign of pregnancy, is materially lessened by the well-ascertained fact that a similar body is formed in the ovary after each menstrual flow, or, more correctly speaking, after each discharge of a ripened ovum. The latter is usually termed a false corpus luteum, and it differs from the true corpus luteum of pregnancy in certain particulars, such as the shorter duration, the less complete development of the stellate structure and yellow color, and the absence of a central cavity. This is the general rule; and the reason usually assigned for the increased growth and development of the corpus luteum of pregnancy is the increased nutrition derived by the Graafian follicle, through the stimulus of impregnation.

The value of this "sign" is still further lessened by the fact that a corpus luteum has been found when there has been neither pregnancy nor menstruation. Tidy cites two illustrations of this last character; one, that of a prostitute who was poisoned by hydrogen cyanid, when neither pregnant nor menstruating, and in whom a fully-ripe corpus luteum was found after death. The other, a woman who died, aged forty-one, from gangrene of a uterine fibroid; the ovary contained a perfectly formed corpus luteum, resembling that of pregnancy. In both these cases the author very properly ascribes the abnormal development to the increased determination of blood to the part; his conclusion being, that "there may be pregnancy without the presence of a true corpus luteum, and also that bodies undistinguishable from true corpora lutea may be found where there has been no pregnancy, and in aged women long past the period when pregnancy was probable.

Instances of precocious pregnancy are mentioned by various writers, occurring as early as in the eleventh and

twelfth years, among the women of India and Abyssinia, and occasionally even in temperate climates. The earliest period of pregnancy that we find recorded is mentioned by Tidy, as given by Mr. Lefevre, of a girl who menstruated at four years, and became pregnant at eight years. Another case is recorded in which pregnancy occurred at eight years and ten months, and the child at birth weighed seven pounds. In another instance, quoted by Wharton and Stillé, menstruation commenced in the first year, and pregnancy in the ninth. The child at birth weighed seven and three-quarter pounds.

Instances of late pregnancy are recorded, often as late as fifty years ; and a case of twins at sixty-four years.

The question whether a woman may become pregnant unconsciously must be answered affirmatively. Women are not infrequently raped when in an unconscious state through narcotism, or the anesthesia produced by ether or chloroform ; and pregnancy may result from such an intercourse, as is well known, but that a woman should be unconscious both of the fact of sexual intercourse, and also continue unconscious of the resulting pregnancy up to the birth of her child, can scarcely be believed, unless she is feeble-minded or idiotic. Cases of this character may occur in unmarried women, who may protest most earnestly their utter ignorance of the whole affair, and pretend to ascribe the pangs of labor to colic or some other disorder ; and who, when the child is shown them, may positively deny all knowledge of its origin.

With married women, the case is quite different. With them unconscious pregnancy is a very possible occurrence. Many instances might be adduced of married women who, having had no children for several years, on becoming

actually pregnant, refused to recognize their true condition, ascribing their increase of size to dropsy, or some other disorder.

Cases may occur when it may become necessary to ascertain the fact of pregnancy in the dead, as, *e. g.*, to determine the identity of a body, and to rescue the reputation of the deceased from the charge of unchastity. It should be remembered that the unimpregnated uterus resists putrefaction longer than any other organ of the body. Casper mentions the case of a young woman whose body was found, nine months after her disappearance, in a privy, so decomposed that the soft parts separated easily from the bones, but the uterus, which was firm when examined, proved to be in the unimpregnated state. This circumstance was of the greatest consequence, as it served to rebut the charge of seduction and murder against a young man, who had been suspected of foul play.

On the other hand, the discovery of a fetus (or a mole) in the uterus of the deceased is, of course, decisive proof of pregnancy; and even years after interment, provided the fetus has reached the period of ossification, traces of its bones may be discovered among the bones of the mother.

CHAPTER IX.

CRIMINAL ABORTION, OR FETICIDE.

Criminal Abortion is the *unlawful* producing the expulsion, and consequent destruction, of the fetus (usually immature) from the womb of the mother. The term abortion, or miscarriage, is understood in medicine to express the expulsion of the fetus before the sixth month of gestation, or before it is considered viable; after this period, it is said to be a premature labor. In law, however, no such distinction is made, the expulsion of the contents of the uterus at any period being considered an abortion.

It is not necessary here to discuss at what period of utero-gestation does the fetus become endowed with life. The fact that it evinces no palpable signs of life before quickening is no proof whatever of the absence of life; it merely shows that the life is extremely feeble in that early stage of its being.

Formerly, the laws of most countries recognized a distinction between an abortion produced before and after quickening, awarding a much milder punishment to the former than to the latter. The more recent laws of the United States and Great Britain recognize no such distinction in regard to the criminality of the act, in relation to the time of commission. But cases of feticide, although extremely common, very rarely become the subject of a criminal trial, unless they have resulted in the death of the woman, in which case it is regarded as murder.

Before considering the medico-legal bearings of the subject, it will be proper to advert to the fact that abortion very frequently occurs from natural causes. With some women a miscarriage results in the early months of every pregnancy, and this in spite of every effort to prevent it. This tendency to abort is greatest at the menstrual periods. Among the causes of the abortion are certain constitutional diseases, as syphilis, small-pox, fevers, albuminuria, excessive passions, poisons, death of the ovum, or disease of the placenta and membranes. The question whether a natural tendency to abort would mitigate the criminality of the act of producing it, when it resulted in the death of the woman, would doubtless receive a negative reply.

The two leading medico-legal questions in every case of feticide are: Has the fetus in utero been actually destroyed, and what are the evidences? Has this been brought about by natural (including accidental) causes, or by artificial (or criminal) means?

I. What are the proofs that a fetus has been destroyed? These are derived (1) from an inspection of what has been expelled from the uterus, and (2) from an examination of the reputed mother.

(1) By an inspection of what has been expelled from the uterus, we can discriminate between a true fetus and other bodies, such as hydatids, moles, polypi, and membranes. The age of the fetus may also be fixed with tolerable accuracy. As regards the nature of the other substances, which may be expelled from the womb, it may be remarked that the true hydatid is exceedingly rare. The hydatidiform, or vesicular mole, is of quite frequent occurrence; it arises from a diseased condition of the villi of the chorion; these become infiltrated with serum, and hang in masses, like

bunches of grapes. These growths are unquestionably the result of impregnation.

Moles are also the result of a diseased condition of the membranes or placenta. The fleshy mole is composed of layers of fibrous matter enclosing a central cavity, in which sometimes fragments of the embryo may be seen. It would seem to result from hemorrhage into the chorion. In the fatty mole there has also been an early death of the fetus, with fatty degeneration of the placenta. A withered fetus may often be observed, connected with the diseased placenta. Both these varieties of moles are positive evidences of pregnancy.

Other substances besides the above may be expelled from the uterus, which are not the result of impregnation, such as false membranes, the product of dysmenorrhea, and also polypi. All these, of course, should be subjected to a microscopic examination before an opinion is ventured, and lest an unwarranted imputation be formed against the character of the woman.

A fact of some medico-legal importance in connection with this subject is that natural abortion usually occurs about the third or fourth month, and the ovum is nearly always expelled entire—*i. e.*, the membranes not ruptured. But as criminal abortion is usually produced about the same time, by perforating the membranes, of course the fetus would, in that case, be expelled first, and the placenta and membranes afterward. This latter circumstance might aid materially in the diagnosis of the case.

(2) The signs of an abortion deduced from an examination of the reputed mother. These signs are by no means satisfactory, especially if the abortion has occurred in the early months of gestation. The discharges of blood and the

relaxed condition of the vagina might easily be ascribed to menstruation, and the somewhat open state of the os uteri might merely indicate some disease of that organ. Hence a woman may more readily conceal her condition in the early, than in the later months of pregnancy; but in proportion as it approaches the full term, the signs of the abortion become more definite, resembling those of delivery, and which will be discussed hereafter.

When, however, death has followed within three or four days after the attempt to procure the abortion, the case may usually be made out satisfactorily; but if the woman survives three or four weeks, it will be almost impossible to determine it by the autopsy, since all the usual signs will have disappeared; and this is especially true where the abortion has occurred in the early stage of pregnancy.

In a fatal case of criminal abortion, the first duty of a physician is to ascertain how far this is to be ascribed to the means employed. For this purpose the vagina and uterus should be examined for marks of injury by the use of instruments. Wounds on the walls of the vagina would indicate the use of instruments, most probably by an inexperienced hand; whilst perforations of the neck of the womb, and sometimes of its fundus, indicate the use of pointed instruments, very possibly in the hands of a professed abortionist.

In some instances a blunt instrument, such as a catheter, is employed; and in a case that some time since came under Dr. Reese's observation, the attempt to perforate the membranes seemed to have failed, while the instrument employed passed up between the membranes and the uterine walls, and tore the placenta, producing internal hemorrhage, and ending fatally. In cases of instrumental violence

there will frequently be discovered marks of metritis and peritonitis. The stomach and bowels should likewise be carefully inspected for signs of irritant poisons (abortives), such as redness and the remains of the various reputed abortives, as powdered cantharides, savin, ergot, etc.; also for the oils of savin, tansy, pennyroyal, etc.; the latter may sometimes be recognized by the odor, or they may be separated by distillation or by ether.

In all fatal cases of feticide the condition of the uterus and its appendages should be examined, so as to form, at least, an approximate estimate of the period of the pregnancy. The uterus in the unimpregnated (normal) state measures (according to Montgomery) about two and a half inches long, one and three-quarter inches broad, and one inch thick. Its size, of course, gradually increases as pregnancy advances, according to the following average: very little change occurs during the first month. During the second month it enlarges considerably. At the end of the third month its length is five inches, of which one inch is for the cervix. At the end of the fourth month it is five inches long from the fundus to the beginning of the cervix. At the end of five months, its length is six inches. At six months, the length is seven inches. At seven months, it is eight inches. At eight months, it is nine to nine and a half inches. At nine months, it is ten and a half to twelve inches in total length.

If death should occur from hemorrhage, at full term, no contraction of the womb will have taken place; but if the woman survive for a few days, there will always be more or less contraction of that organ. In two days after delivery (at full term), the womb will have contracted down to seven inches in length and four in width; after one week it will

be about five or six inches long and two wide; after two weeks, the length is four or five inches, and the width one and a half inches. At the end of the second month, it will have attained its normal size.

Its shape also changes as well as its size. In the unimpregnated state it is flat, pyriform, and somewhat triangular. After impregnation it assumes somewhat of a globular shape; but no change of consequence occurs in the cervix until about the fifth month, after which it progressively shortens, losing one-fourth its length in the sixth month, another fourth in the seventh month, still another fourth in the eighth month, and at the close of the ninth month, or full term, becoming entirely obliterated, so that at this period the shape of the uterus is ovoid.

The thickness of its walls at full term is about that of the unimpregnated condition—one-third to two-thirds of an inch; but in a few hours after delivery, under contraction, its thickness increases, often to two inches.

The uterine vessels undergo considerable enlargement in pregnancy—especially the veins, which attain such dimensions as to be denominated sinuses, at the position where the placenta is attached. The ligaments of the uterus likewise share in the general change. The broad ligaments become gradually effaced, in consequence of being absorbed (so to speak) in the increased development of the uterus. The round ligaments increase in thickness. Both become extremely vascular.

The Fallopian tubes increase in size, become less convoluted, and are much more vascular. Usually that one through which the ovum has passed is somewhat the larger. The ovaries also share in the general increased vascularity. That one from which the ovum escaped dis-

plays a peculiar fullness or prominence at one portion of the organ. If this be cut open, a yellowish-looking body will be observed, named corpus luteum, which has already been described.

It should not be forgotten that all the above signs of abortion may occur after the expulsion of hydatids and moles; also, that a corpus luteum may be found in the virgin state.

It will be proper here to describe the gradual development of the fetus, together with its appearance at the different stages of its growth, so as to furnish the data for establishing its probable uterine age. At the earliest period when the human embryo can be discerned (from fourteen to eighteen days), it presents the appearance of a flocculent mass, of a semi-transparent, gelatinous consistence, about two and a half lines in length.

In the third or fourth week, the length of the embryo is from four to six lines; the weight twenty grains. Its form is curved, and already the rudiments of the several organs are visible in the shape of dots and protuberances. At the end of the eighth week, the length is fifteen to eighteen lines; the weight, two to five drachms. The head forms more than two-thirds of the body; the features are more distinguishable, and the sex may sometimes be made out. At the end of the twelfth week (three months), the length is two and a half to three inches; weight, one to two ounces. The whole ovum is now about the size of a goose egg. The fingers are separated, but the toes not; the genital organs very prominent. At the end of four months, the length is five to seven inches; weight, six to seven ounces. The skin rosy, very delicate, and covered with a fine down; hair on

the head short and silvery. The disproportionate quantity of the amniotic liquor disappears, and the fetus nearly fills up the cavity of the uterus. At the end of five months, the length is from eight to ten inches; weight, eight to ten ounces; nails distinct; the head, liver, heart, and kidneys disproportionately large. If abortion occurs now, the membranes are usually first ruptured, and the fetus escapes.

At the end of the sixth month the length is about twelve inches; weight, about one pound or over. The color of the body is of a cinnabar-red; down and sebaceous matter cover the skin; umbilicus a little above the pubis; fat in small quantities under the skin; head very soft; fontanelles widely separated; palms of hands and soles of feet purplish; scrotum empty; labia project, but do not conceal the clitoris; the *membrana pupillaris* still distinct; nails distinct; meconium in small quantity in the large intestines; bladder hard and pyriform, with a very small cavity. At the end of the seventh month, the length is fourteen to fifteen inches; weight, two to four pounds. The skin is of a dirty-red color; hair on the head about half an inch long; *membrana pupillaris* disappearing; eyelids no longer adherent; nails more firm; convolutions begin to form on the brain; meconium is more abundant; the ears lie close to the side of the head. If the child should now be born, the arms and legs will be bent in the position they maintained in the womb.

At the end of the eighth month, the length is fifteen to sixteen inches; weight, three to four pounds. The skin is thicker and more natural, and is covered with a fine, soft hair; hair on head is darker; nails firmer; breasts often projecting; the testes still at the rings, but often one (the left) is found in the scrotum; lungs are reddish; liver still very large; *membrana pupillaris* absent. At the end

of the ninth month, the length is eighteen to twenty inches; weight (average) seven pounds; ossification more complete; bones of cranium touch each other; fontanelles smaller; hair on head longer and darker; nails more solid, and prolonged to the ends of the fingers; convolutions of brain more numerous; lungs redder and more voluminous; meconium nearly fills the whole intestine; bladder contains urine; both testes descended, and vulva closed.

In the development of the fetal brain, its form and disposition, as also that of the spinal cord, can be recognized as early as the eighth week. In the third month, the tubercula quadrigemina, optic thalami, and corpora striata are seen; the medulla oblongata can be distinguished about the sixth or seventh month. The gray portion is not formed until nearly the end of the ninth month. The weight of the fetal brain, as stated by Wenzels, is—at five months, 720 grains; at eight months, 4960 grains; at nine months, 6150 grains.

The point of insertion of the umbilical cord will aid in determining the age of a fetus, when about its full term. From numerous observations, the conclusion arrived at is, that at full term the cord is inserted a few lines below the middle of the body; earlier than this, the point of insertion is at the centre. Moreau's observations, at the Maternité of Paris, show, that out of five hundred cases at full term, in only four was the umbilicus exactly in the centre of the body; in all the rest, it was from eight to ten lines below it.

Béclard and others have pointed out a very certain test of the age of the fetus about the full term, viz., the osseous deposit in the inferior epiphysis of the femur. If there is no visible trace of this, the fetus cannot be over eight months;

if it has the size of a hemp seed (half a line), it is in the ninth month ; and if from two to three lines in diameter, it has arrived at full term ; if more than three lines, the child has probably lived after its birth.

The weight of children born at the full term varies very considerably. As already stated, the average weight may be taken at about seven pounds,—rather less in females ; but, in many instances, the weight far exceeds this. Dr. Owens mentions one that weighed seventeen and three-quarter pounds, and that measured twenty-four inches in length. Dr. Meadows gives one that weighed eighteen pounds and two ounces, and measured thirty-two inches. Dr. Donellan, of Louisiana, mentions a case of triplets, of which one weighed nine and a half pounds, one seven and a half pounds, and one seven pounds, the united weight being twenty-four pounds. On the other hand, children at full term often fall below the average, weighing only from four to six pounds.

II. The second medico-legal question is, Was the abortion produced by natural, or by artificial (criminal) means ? The examination of the reputed mother, especially if death has resulted, would generally settle this question satisfactorily by the presence or absence of the results of instrumental or other interference. It will be proper here to point out the various means that are generally resorted to in order to effect the purpose. These criminal means may be considered under the heads of general and special. And here it may be premised that, as an almost universal rule, where there is no constitutional predisposition on the part of the woman to abort, this process can very rarely be effected except by instrumental interference. Hence, the violent

measures which are sometimes resorted to to accomplish it. Many cases are reported where severe bodily injuries have been inflicted with a view to bring on an abortion, but without the desired result. The most violent exercise, and the most brutal violence have been submitted to without success.

1. *The general means* include repeated blood-letting, emetics, and drastic purgatives. Blood-letting often acts as the most effectual means of preventing abortion in plethoric women; nevertheless, if it could be shown in a case of abortion that the female had previously resorted to frequent bleedings, this fact might be received as presumptive evidence against her. The same is true of the employment of leeches.

The above remarks are also applicable to the use of emetics. Although violent vomiting might bring on premature labor in the last stages of pregnancy in feeble women, it can have no effect in the earlier months. The well-known nausea and vomiting (the latter sometimes quite violent) of pregnancy do not produce miscarriage.

The drastic cathartics are often resorted to for the same purpose; they may possibly effect it in weak women, especially if predisposed to miscarriage, but as a general rule they are powerless.

2. *The special means employed* comprise the use of certain drugs which are supposed to possess the power to excite uterine contraction, and are therefore named emmenagogues and abortives; and also the use of instrumental measures for the purpose of puncturing the membranes, and so inducing uterine contraction. The number of the popular abortives is very considerable; only a few need be noticed here.

Ergot, or *Spurred Rye*, undoubtedly possesses ecbolic properties; that is, it is capable of causing contractions of

the uterus during labor, but it is not certain that it can affect this organ in the earlier stages of pregnancy. It is, however, certain that it very often fails to bring on miscarriage, although large and repeated doses have been taken.

Cotton root (*Gossypium herbaceum*) has a wide reputation as an abortive. It is even said to be more certain and powerful than ergot.

Savin (tops of *Juniperus sabina*) is highly esteemed as an ecbolic. Its virtues depend on a volatile oil (oil of savin), which is also much employed as a popular abortive. Savin is a powerful irritant to the stomach and bowels. The oil has frequently caused death through peritonitis and gastritis, without discharging the fetus. It is an exceedingly dangerous remedy. Pansy, pennyroyal and rue all act in a similar manner; they each contain a powerful volatile oil, which is considerably used as an abortive, but in the majority of cases without the result intended. They frequently produce the death of the woman through their violent irritant action. Various other substances are employed as abortives, such as cantharides, copper sulphate, cimicifuga, and potassium iodid, etc. Of one and all of the above reputed abortives it may be affirmed, without contradiction, that they are uncertain in their operation on the uterus, that they always endanger the mother's life, and that they not infrequently destroy the mother, without effecting the discharge of the fetus.

The special means also comprise blows and violent pressure made upon the abdomen, loins, and back of the woman. Occasionally, but by no means always, such procedures may result in the expulsion of the fetus, but they necessarily entail great risk of life to both mother and child. The use of pointed instruments introduced into the uterus so as to

rupture the membranes is the only certain method of producing uterine contraction and insuring the expulsion of its contents. This operation in the hands of empirics, or of the female herself, is often followed by very serious and fatal consequences, from wounding and even perforating the womb. Other methods are sometimes successfully employed, as the injection of warm water between the uterus and ovum, and the dilatation of the os uteri by means of sponge and other tents, or by the use of Barnes' dilator. A case is mentioned by Dr. Channing, in which a bent wire was introduced into the uterus, where it became entangled in the tissue and had to be cut off; the piece remained within for six years, and, singular to remark, the case was one of merely suspected pregnancy. In another case, strong sulphuric acid was injected into the vagina for the purpose of bringing on an abortion. The result was violent inflammation, causing adhesion of the walls of the vagina, and also of the bladder. The Cæsarean section was finally performed, which terminated fatally.

Druggists are often asked for substances to produce abortion, and in order not to offend by refusing to sell, yet not involve themselves in a criminal act, dispense harmless powders, such as milk-sugar or starch mixed with a small amount of quinin to give a marked taste, and thus lead the person to believe that an active drug is being used.

Before leaving this subject, it is proper to state that the operation for abortion may sometimes become necessary in regular medical practice. The cases demanding it are deformity of the pelvis to such an extent as to preclude the possibility of delivery of a living child at full term; and possibly when the vomiting during pregnancy is of such a

violent and continued character as actually to endanger the mother's life. In every such case, however, the practitioner should secure a consultation before venturing to perform the operation.

Abortion may sometimes be feigned for sinister purposes, such as to secure compensation for an alleged seduction and consequent pregnancy, or to excite sympathy and aid. In such cases, a thorough examination of the woman and the alleged fetus will serve to clear the matter up.

Legally considered, the criminality of abortion is not affected by the fact that the woman was not really pregnant, nor by the birth of monstrosities or of moles, nor by the fact of an extra-uterine pregnancy.

CHAPTER X.

INFANTICIDE.

By **Infanticide** is understood the criminal destruction of the new-born child. In a legal sense, it is immaterial whether the child is killed immediately after its birth, or a few days subsequently.

The crime of Infanticide has been prevalent throughout the world, from the remotest period of history. Before the establishment of Christianity it was allowed among the most enlightened and cultivated nations of the earth, and even at the present day its practice is frequent in the most civilized countries, although placed under the ban of the law, and involving mostly the destruction of illegitimate children. Child-murder is treated by the law like any other form of homicide, and tried by the usual rules of evidence in such cases. There is this important point in the nature of the medical evidence required, namely, that it must prove satisfactorily that the child was born alive; in other words, the burden of proof that a living child was destroyed is thrown upon the prosecution. The law humanely assumes that every child is born into the world dead, until the contrary is shown, because so many children do thus actually come into the world, and many others die very soon after, from various causes; and in these latter, the signs of their having lived are frequently indistinct. As the charge of infanticide can never be sustained unless there is distinct proof that the child was legally alive at its

birth, great difficulty is usually experienced in obtaining sufficient evidence to convict a woman accused of this crime. As a general rule, she has been delivered in secret, with no witness of the birth; and the body of the child is frequently concealed or destroyed. There is, besides, a general reluctance on the part of a jury to convict a woman of willful murder for this crime, horrible as it is, on account of a feeling of sympathy for the prisoner arising from the probability of her seduction and desertion.

The term "born alive," in the legal sense, implies the complete expulsion of a living child from the mother. A child is not "born" legally, if any portion of its body—a leg, for instance—is retained within the vulva. Hence, through a fiction of the law, the destruction of a living child, if only partially born, is not regarded as murder! It is not, however, necessary that the umbilical cord should be cut, in order to come within the meaning of the statute.

In the majority of cases of infanticide, the child has arrived at the full term of gestation; but, as children are often born at an earlier period,—either naturally, or by artificial means,—the examiner should be prepared, from the inspection of the body, to give an opinion as to the probable age that the child had attained in the uterus. For this purpose, he should be acquainted with the general appearance, size, and development of the fetus at the different periods of its uterine life.

In a case of infanticide, the medico-legal questions involved pertain, first, to the infant, and, secondly, to the reputed mother.

I. Questions relating to the infant: (1) *Was it born alive?* (2) *What was the cause of its death?* (3) *Its age?* (4) *The interval since its death?*

(1) *Was it born alive?* In the absence of all positive evidence from witnesses, the inference must be derived from the external appearance, and from the internal examination of the child's body. The general appearance of the body of an infant that was born alive, at full term, and had breathed, may be described as follows: The remains of the sebaceous matter (*vernix caseosa*) will usually be found under the armpits and behind the ears; the hair will be dry and clean; the ears do not lie so close to the side of the head as in dead-born children; the eyes remain half open, in spite of all efforts to close them; the *caput succedaneum*, or swelling on the back of the head, is much more distinct than in the still-born child; the former contains a glutinous, bloody serum, while in the latter there is only a small quantity of colorless liquid. The thorax is more arched, and the diaphragm more depressed, than in the case of the still-born. According to Casper, the highest level of the diaphragm in the still-born child is between the fourth and fifth ribs, while it descends to between the sixth and seventh in the living. The lungs will also present unmistakable evidences, which will be described later. The remnant of the umbilical cord attached to the body will exhibit evidence of commencing desiccation, if the child has lived for a few hours.

A dead-born child, having perished immediately before its birth, will usually be found more or less covered with the *vernix caseosa*; its hair closely agglutinated; ears lie close to the side of the head; eyes closed, and eyelids, when raised, do not remain open; mouth closed, and a drop of watery blood is often seen trickling from the nostril. The thorax appears flat and unexpanded; the trachea is flattened, and often contains a viscid, mucous secretion. The lungs lie in the posterior part of the thorax; they are

of a brownish-red color, have a granular structure, and do not crepitate upon pressure; their length is greater than their breadth, and their edges are rounded. The remnant of the umbilical cord has a fresher look than when the child has lived a few hours.

If the death of the fetus has occurred some time before its birth, there will be the following signs of intra-uterine putrefaction: The body is extremely flaccid and flattened, as if it had been macerated in water; the skin is spotted, and the cuticle detached in many places, especially on the abdomen; the head lies perfectly flat in any position; the bones of the cranium move easily on one another; the face is flattened and the features distorted. The cellular tissue and cavities are infiltrated with a bloody serum; the viscera are easily loosened from one another; gas is developed in the lungs and liver. The color of the lungs is dark brown. There is an absence of the usual odor, and also of the green color of ordinary putrefaction.

It is important to have clear and definite ideas concerning the proofs of a live birth, in cases of infanticide. It is well known that many children come into the world still-born—that is, without giving any sign of life by respiration or otherwise—and yet, by proper attention, they subsequently revive and continue to live. From this it is to be inferred that respiration is not the only evidence of a live birth. Nevertheless, in the cases of infanticide that come under judicial investigation, in which the proofs of a living birth are to be discovered solely by an inspection of the dead body of the child, the fact of respiration is the main point to be determined by the examiner. If this fact can be satisfactorily proved, there can be no doubt that the child had lived; but it does not necessarily prove that it

was born alive, since it might have perished (naturally or otherwise) before it was actually born, in the legal sense. Again, a child may live for several hours after its birth, breathing very feebly; and after its death the air cells of the lungs may present no evidence of distention; so that, judged by this single sign presented after death, the child would be said to have been born dead.

As to the question whether any evidences of life before respiration can be discovered in the dead body in a case of infanticide, the answer must be that, at present, there are no satisfactory medical data to enable one to express a positive opinion in such cases—certainly not from a mere inspection of the lungs. Should there, however, be other evidence, such as marks of great violence upon the body, or proofs, through witnesses, that respiration had been designedly prevented, either by the woman herself or by an accomplice, such circumstances would certainly afford very strong presumption of murder. Dr. Caussé, quoted by Taylor, contends that a true ecchymosis found on the body of a new-born child is proof that the blood was circulating at the time, and that it had been extravasated, which could only occur in a living body; and that this proof would be strengthened if the blood was found coagulated, and the surrounding tissues deeply infiltrated. Devergié held a similar opinion in relation to the significance of ecchymoses and infiltration of blood. Still, while fully admitting the force of these proofs of vitality as good medical evidence, they are scarcely to be received as sufficient of themselves to establish the charge, since they are open to the objection that the injuries might have been inflicted during birth, or accidentally after birth.

Proofs that the Child has Breathed.—These proofs are

derived (1) from the organs of respiration; (2) from the organs of circulation; (3) from the abdominal organs.

1. *Proofs afforded by the respiratory organs.*

(*a*) The thorax is higher or more vaulted in appearance than when the child has not breathed; its capacity is increased; but the attempt to indicate these changes by actual measurements and comparisons cannot be depended upon, on account of the natural difference in the size of the thorax in different children at birth.

(*b*) The diaphragm is considerably more depressed after respiration has been established than before; according to Casper (as already mentioned), in children born dead its highest point reaches between the fourth and fifth ribs, whereas in those born alive and fully respiring it descends to between the sixth and seventh ribs; the position of the diaphragm may also be affected by the gases produced during putrefaction.

(*c*) The larynx, before breathing, is narrower, contains more or less mucus, and is closely approximated to the epiglottis; after respiration it is wider, and is not closed by the epiglottis.

(*d*) The Situation and Volume of the Lungs.—Before breathing, these organs are placed far back in the thorax, so as almost to escape notice. After complete respiration they project forward so as completely to fill the cavity of the chest, and cover, and to a great extent conceal, the heart and pericardium. If respiration has been imperfect, the volume of the lungs is proportionately less developed.

(*e*) The Consistence of the Lungs.—Before respiration they have a firm and compact feel, and they are of the consistency of liver; after full breathing they are spongy and

crepitant to the touch. When cut, there is an escape of blood-froth; and when pressed between the fingers under water, air-bubbles will rise to the surface. A thin section, when examined by the microscope, will show distinct air cells. It must, however, be remembered that the lungs of infants that have lived a considerable time after birth, but that have breathed very imperfectly, will sometimes not crepitate under the finger, nor will they float on water.

(*f*) Their Color.—Before respiration, this is bluish-red or violet, resembling that of the spleen. A short exposure to the air will render the color brighter. After full respiration their color changes to a pale red, becoming bright scarlet after free exposure to the air, or else irregular bright spots appear upon a bluish-red ground, giving them a marbled appearance, a peculiarity which cannot be given to fetal lungs by artificial inflation. "This insular marbling of the lungs is characteristic of lungs that have breathed, and is due to the presence of blood in the vessels surrounding the inflated lung tissue" (Husband). In imperfect respiration, and as a result of disease, the color of the lungs may be much modified.

(*g*) Their Absolute Weight, or the Static Test.—The weight of the lungs before respiration is less than after that process has been established, owing to the presence of blood circulating in them. The average weight before respiration, derived from nine cases, according to Taylor, was 649 grains. Dr. Traill gives it as varying from 430 to 600 grains. The average weight after respiration, in three cases, was 927 grains. From these data attempts have been made to institute comparisons in unknown cases; but so much depends upon the maturity or immaturity of the child and the degree of respiration, that the test is unworthy of confi-

dence. Great weight of the lungs cannot, of itself, furnish proof of respiration, unless accompanied by increase of volume from the presence of air, and by crepitation and the distention of the air cells; it may really be due to disease. Dr. Taylor relates a case where the lungs weighed upward of 1200 grains; they contained no air, and when cut into thirty pieces not one floated on water.

Specific Gravity of the Lungs.—This is greater before than after respiration; because the air received throughout the air cells in breathing more than counterbalances the additional weight derived from the blood circulating through them. Dr. Taylor found, as the result of several experiments, that the specific gravity of the lungs in the fetal state varied from 1.04 to 1.05; after respiration it was 0.94 (one experiment). It will, of course, be understood that the specific gravity of the substance of the lungs remains unchanged; it is only rendered apparently lighter by the introduction of air into the cells. The introduction of a very small quantity of air is sufficient to render the fetal lungs buoyant in water; and it matters not whether this air is derived from respiration, artificial inflation, or putrefaction. It is on this property of the lungs that the application of what is termed the hydrostatic test is founded.

The Hydrostatic Test—Docimasia Pulmonum.—The principles involved in this test have just been noticed—the fact that the lungs in their fetal or unaërated condition sink when put into water, while the lungs of a child that has breathed, or where they have been otherwise inflated, float in water.

The mode of applying this test is very simple. Having carefully removed the lungs from the chest (usually along with the heart and thymus gland), these should be put into

a sufficiently capacious vessel containing distilled, or river water, at 60° F. If they are very buoyant, much of them floating on the surface of the water, this indicates very complete aëration of the lungs, and may be regarded as a strong proof of respiration at birth. If they are less buoyant, floating largely under the surface, the indication is that the aëration was not complete. Each lung should now be tried separately, to determine if each is equally buoyant. Then each one should be divided into about fifteen pieces, and each fragment separately tested. If all the pieces float, even after firm compression, the inference would be that respiration had been very perfectly performed. If they sink, it should be noticed whether this occurs rapidly or slowly. The lungs should then be tested separately—one may sink, while the other (commonly the right) may float. Supposing both to sink, they should each be divided into pieces, and each one tried separately, as before described. If all the pieces sink, the inference is that, although the child may have survived its birth for a short time, there is no evidence of its having breathed.

Much useless discussion has occurred as to the true value of the hydrostatic test in a case of infanticide. It must be evident, on a careful consideration of the principles involved in this test, that it can only prove the aëration or the non-aëration of the child's lungs; it does not necessarily prove respiration, although it establishes a very strong probability of it. Moreover, as respiration may take place—partially, at least, as in certain cases of face presentation, where the labor has been protracted and the vagina widely dilated—while the head was yet in the uterus or in the vagina, and frequently after the head has been born, but before the complete extraction of the body, it follows that the hydro-

static test can never prove a live birth, but merely that the child had breathed, and therefore was alive at or about the time of its birth.

Two objections have been offered against the hydrostatic test which deserve notice.

I. *That the lungs may float although the child may not have breathed*—(*a*) from artificial inflation; (*b*) from putrefaction; (*c*) from emphysema.

(*a*) *Artificial Inflation.*—In reply to this objection it may be stated that it is extremely difficult to distend the whole lung artificially through the mouth, even if a tube and bellows be employed; most of the air will be found to have passed into the stomach. Besides, the force of the objection seems to be met by the fact that, in a case of child murder, the great object of the woman and her accomplices is to make it appear that the child was born dead; they would, therefore, hardly be likely to adopt measures that would suggest a strong probability of a live birth.

It must, however, be admitted that, while artificial inflation of the lungs can never be mistaken for perfect respiration, it might be confounded with imperfect breathing. In both cases, the lungs will be more or less buoyant; they will crepitate under pressure; when divided into fragments many of these will float on water; and, in some exceptional cases, firm pressure made on pieces of a lung artificially inflated through a tube has failed to cause these pieces to sink. As a general rule, strong compression on a fragment of lung artificially inflated by the mouth will so completely remove the air as to cause it to sink in water; whilst no amount of force, short of an entire disintegration of tissue,

will prevent the floating in cases where natural respiration has been fully performed.

There are other points, however, to be noticed in making the diagnosis, viz., that artificial inflation does not increase the actual weight of the lungs, like respiration, because it does not invite the blood into them ; and also that the color of the artificially-inflated lung is a uniform cinnabar-red, without any marbling. The explanation of this will be obvious on reflection. Natural respiration tends to create a vacuum in the lungs, and consequently to draw into them the blood of the pulmonary arteries, which gives them the comparatively dark-bluish and marbled appearance alluded to ; but artificial respiration, by which air is forced into the lungs, tends, by the pressure of that air, to exclude the blood, and consequently to render the color of the lungs still lighter than before. A fragment of the lung squeezed under water will exude air, but no blood (Lutaud). Casper's opinion about the matter is : " When we observe a sound of crepitation, without any escape of blood-froth on incision, laceration of the pulmonary air cells with hyperemia, bright cinnabar-red color of the lungs without any marbling, and perhaps air in the artificially inflated stomach and intestines, we may, with certainty, conclude that the lungs have been artificially inflated."

(*b*) *Putrefaction.*—It is admitted that the lungs of a dead-born child will float, as the result of the gases generated by putrefaction. The air thus evolved is not contained in the air cells of the lungs, but in the cellular tissue, and chiefly between the lobes and lobules. Moreover, it collects in rows or bubbles, which are much larger than the air vesicles, prominent, and disappearing entirely under slight pressure.

At the same time, the lungs themselves present other evidences of putrefaction, such as a greenish color, a fetid odor, and diminished consistence. If a portion be cut out from the interior of the lung it will be found to sink in water. Again, if the air be squeezed out of a portion of the lung it will no longer float in water. There is also a want of crepitation in a putrescent lung.

The exact period when the fetal lungs undergo putrefaction cannot be fixed; but it is known that it is delayed much longer than in the other organs of the child; consequently, in a doubtful case, if the other organs give no evidence of decomposition we may be certain that the buoyancy of the lungs is not owing to putrefaction. After complete decomposition the lungs again sink in water. There ought to be no difficulty in distinguishing between the buoyancy of respiration and that resulting from putrefaction, in employing the hydrostatic test.

(*c*) *Emphysema.*—This was formerly regarded as a diseased (congenital) condition of the lungs, which caused them to float in water in the absence of respiration; but its existence is considered as questionable. Casper's decided opinion is that, "as yet not one single well-observed and incontestable case of emphysema developing itself spontaneously within the fetal lungs is known; and it is, therefore, not permissible in forensic medicine to ascribe the buoyancy of the lungs of new-born children to this cause."

II. *That the lungs may sink in water, although the child may have breathed and lived.*

(*a*) *From disease*, as pneumonia, congestion and atelectasis pulmonum. These would increase the density of the pulmonary tissue, and cause it to sink in water. But the

first two conditions are extremely rare in the new-born child, and the latter is to be regarded as simply the original fetal, undeveloped condition of the lung (Casper, Meigs). If ever found they can be readily recognized by their general appearances, and also by dividing the lungs into pieces and finding that some of the fragments will float. In the case of congestion, if a piece of the lung be squeezed so as to remove the blood, it will be found to float.

(*b*) In those cases in which the child has survived for some time, but the respiration is so feeble as not to inflate the lungs, the hydrostatic test will generally, though by no means always, discover the presence of air in a few of the pieces of the lungs, when these have been divided. In case every fragment sinks this test can, of course, render no assistance, a circumstance which is certain to be regretted, inasmuch as it does not permit us always to ascertain the truth.

The general deductions from the two foregoing objections are the following :—

1. The lungs float (1) from natural respiration ; (2) from artificial inflation ; (3) from putrefaction ; (4) from emphysema (possibly). Therefore the mere buoyancy of the lungs is not, of itself, positive proof of respiration ; but, with proper precautions, the test may be depended upon.

2. The lungs sink (1) from total want of respiration ; (2) from feeble or imperfect respiration ; (3) from disease. Hence, the mere sinking of the lungs in water is not of itself a positive evidence that the child has not breathed ; but with due precautions it may be regarded as a safe test.

As the hydrostatic test is of such importance in cases of infanticide, great carefulness should be observed in its

employment. The chest should be properly opened, and the position, size, color, etc., of the lungs accurately noted. The great vessels are then to be tied and cut at their roots. The trachea is to be divided as close as possible to the lungs; these are next to be taken out, together with the heart and thymus gland, and closely examined for disease or putrefaction, also for crepitation on pressure. A suitable vessel, containing fresh water at 60° F., should be provided. It is important to attend to the temperature of the water, since its buoyant power varies considerably between 40° F. and 212°. For the sake of uniformity the mean temperature of 60° should always be employed. For a similar reason fresh and not salt water ought to be used. The lungs, together with the trachea and bronchi, are then to be placed in the water, and it should be noticed whether, and how, they float or sink. The lungs should then be separated from the heart and from each other, and accurately weighed. They should again be placed separately in the water and the result noticed. If one only floats, note which one it is. Each lung should then be cut up into about fifteen pieces, and each piece submitted to the test. They should next be subjected to suitable compression, by enclosing them within the folds of a towel and pressure applied; after which they should again be put into the water, and the result noted as to whether they continue to float or not.

There are a number of striking peculiarities in the circulatory organs of the fetus, which are modified or entirely lost after respiration is established. A knowledge of these changes is therefore of importance in a case of infanticide. The evidence to be derived from the changes in the heart and fetal vessels comprises the examination of the *foramen*

ovale, the *ductus arteriosus*, the *ductus venosus*, and the umbilical cord. Although as a general rule the closure of the three first-named openings takes place at birth or soon after, yet in many instances it occupies a considerable time, so that in cases of infanticide the test is, practically, of little or no value.

The *foramen ovale* is the opening between the two auricles of the fetal heart, through which, before respiration, the blood passes directly from the right to the left side of that organ. It usually closes at birth, or very soon after, but instances are known where it continues open up to adult years, and even throughout life.

The *ductus arteriosus* is a vessel about half an inch long, which in the fetus forms a direct communication from the right ventricle to the aorta; it may, in fact, be regarded as a direct continuation of the pulmonary artery to the aorta. The effect of this arrangement is that most of the blood from the right side of the heart, instead of being propelled to the lungs through the right and left branches of the pulmonary artery, is sent directly to the aorta, and thence into the general circulation. The branches of the pulmonary artery, in the fetal state, are small, inasmuch as they transmit but little blood.

As soon as respiration commences, the *ductus arteriosus* begins to contract—at first at its aortic extremity, and gradually throughout its calibre, until, finally, the whole vessel dwindles down to an impervious cord. During this same period the branches of the pulmonary artery increase in size, in order to transmit the due supply of blood to the lungs, which are now performing their proper function. The closure of the duct, although usually a proof of a living birth, is by no means uniformly so; neither is its open con-

dition a positive evidence of a dead birth, since its closure is gradual and frequently protracted.

The *ductus venosus* arises from from the umbilical vein, and opens into the ascending *vena cava*. It is found in the posterior part of the longitudinal fissure of the liver. Its closure is apt to occur rather sooner than the other openings before alluded to; but it is quite uncertain as a sign of a live birth.

The umbilical vessels consist of a vein and two arteries. The former conveys the blood aërated in the placenta to the fetus, passing in at the umbilicus; and proceeding onward it divides, one part going into the liver and the other part going through the *ductus venosus* into the ascending *vena cava*, and so carrying purified blood to the right auricle of the heart. The two umbilical arteries are continuations of the hypogastrics; they convey the effete blood out of the body, through the navel, back again to the placenta, there to be renewed. After birth, when the route of the circulation undergoes such a complete change, these vessels become closed and obliterated; but the exact time when the closure takes place is hardly more certain than in the case of the other fetal channels.

The *desiccation of the umbilical cord* affords valuable evidence of a live birth, especially if the child has survived several days. The cord is usually of a bluish, pearly-white color, about the thickness of a finger; and within twelve to twenty-four hours after birth loses its polish, becoming dry and flaccid. It is generally cut and tied about three inches from the umbilicus, at the time of the birth. The process of desiccation commences at the severed end; in the course of twenty-four hours it reaches to within half an inch of the navel, this portion still remaining pulpy, and of an amber

color. About this time the skin of the abdomen around the umbilicus becomes red and swollen, and is pushed up around it in the shape of an inverted cone. During the second and third day the cord gradually withers and dies, becoming flattened and twisted, and suppuration begins on the still moist portion attached to the navel. A line of demarcation is seen forming; and on the fourth day the free end of the cord becomes of a yellowish-brown or black color, and has the appearance of transparent glue. The separation of the cord usually occurs on the fourth, fifth, and sixth days—the majority of cases being on the fifth. Occasionally, the separation takes place some days later.

The existence of an inflammatory zone about the umbilicus is one of the signs of importance in judging whether an infant has lived after birth. In one case Dr. Kirk, of Edinburgh, found such a zone and gave judgment that the child had lived. As the result of subsequent investigation of several cases, he came to the conclusion that if a child lives an hour after birth there will be a slight circle of inflamed tissue about the insertion of the cord; this zone becomes more pronounced every hour after birth.

Although the separation of the cord is a vital act and can occur only in a living child, its desiccation make take place equally in a dead child, although it occupies a much longer time in the latter, sometimes not commencing for several days after birth. But the important point of distinction between the two is that spontaneous separation of the cord never occurs in a dead-born child; it merely withers and dries up, but remains attached. Hence, the desiccation and separation of the cord and the subsequent cicatrization afford positive proof that the child was born alive, and had continued to live some days after its birth.

In the fetus the liver is, relatively, enormously large and very vascular, doubtless in consequence of the important function it has to perform in connection with the circulation of the blood. Meckel found the absolute weight of the liver to diminish until the end of the first year of extra-uterine life. In five new-born children the liver was found to be one-fourth heavier than in five other children of eight to ten months old.

The stomach and intestinal canal may sometimes afford positive proofs of a live birth, from the discovery therein of certain matters—liquid and solid—such as blood, milk, farinaceous and saccharine articles. The two former substances may be identified by the microscope, which, however, fails to distinguish between human and cow's milk; but the detection of colostrum corpuscles in the contents of the child's stomach would be good evidence that the milk was from a woman very recently delivered. Another test for the presence of milk is that of Trommer for milk-sugar. The suspected substance, properly diluted, is treated with a few drops of a weak solution of copper sulphate, sodium hydroxid added in excess, and then boiled; a red precipitate indicates the presence of sugar.

Starchy matters may be easily recognized by the application of tincture of iodin, which imparts a deep blue color; and also by microscopic examination, which may even identify the particular variety of starch—as arrowroot, potato starch, etc.

The presence of blood in the stomach is not necessarily evidence that the child was born alive, since it is possible that it might have been drawn into the throat from the maternal discharges, during the passage of the head through the outlet, and before it had breathed.

The presence of meconium in the stomach, like that of blood, is not a positive indication of a live birth, because the child may have drawn it into the stomach and air passages by aspiration, in the passing of the head over this substance, through the outlet. Meconium is recognized by its dirty, dark-green color and want of fecal odor. The microscope shows it to contain crystals of cholesterol, epithelial scales, masses of green coloring matter of bile and granules.

The absence of meconium from the intestines (where it is usually found at birth), and also the absence of urine from the bladder, are not, necessarily, evidences that the child has been born alive, since these liquids may be discharged during the act of birth.

II. *Causes of Death in the New-born Child.*—Having disposed of the Question I—Has the child been born alive?—we are now prepared to discuss the second, viz.: What was the cause of its death? These causes are various. They may be considered under the heads of such as act during birth, and such as act subsequently; also, such as are accidental, and such as are criminal. It is the latter only that can be connected with a charge of infanticide.

In an investigation of this character it should be remembered that many children are still-born, the proportion being one in every eighteen or twenty of legitimate children. Among illegitimate children the proportion is much greater—probably one in ten (Taylor). As before mentioned, this throws the burden of proof of a live birth, in a case of infanticide, on the prosecution, as the law assumes in all such cases that the child was born dead.

1. *Causes Acting during Birth.*—(1) Compression of, and

by, the umbilical cord. This may happen in breach or foot presentations; also when the cord is prolapsed in these, or in head presentations. In such labors it is well understood that unless the cord is speedily relieved of pressure, the child will perish. Another cause of compression arises from the cord being wound round the child's neck. This is quite a frequent complication, according to Elsasser, being found as often as one in every five cases. In the latter instance death may proceed either from the constriction of the child's neck, by the cord causing congestion of the brain, or from the interruption of the flow of blood in the cord itself, owing to the strain upon it. The effects of the constriction of the neck by the cord are not precisely similar to those of strangulation in a child that has breathed; and inasmuch as children are not infrequently purposely strangled after the head is born, and before the rest of the body is expelled, it is important to understand if there are any means of distinguishing between the two cases.

In the last-mentioned case, if the child had not breathed when the strangulation was effected, there would be no means of distinguishing it from death occasioned by constriction of the cord, except where marks of the ligature have been left upon the neck of the child. The question then is, Does the cord ever leave such a mark upon the neck? The cases are extremely rare in which the cord leaves any mark identical with that produced by a ligature in actual strangulation. Elsasser states that of 327 cases of labor in which the cord was twisted around the child's neck, there was one fold of it in 228 cases; two folds in 83 cases; three in 13 cases, and four in 4 cases; yet in the whole series there was not a single instance in which the least mark, impression, or ecchymosis was visible. In some

cases the cord was so tightly wound round both neck and body that it was necessary to divide it before delivery could be accomplished. There are some instances reported by trustworthy authorities, in which the umbilical cord has left very positive marks upon the neck of the child, sometimes a mere furrow or depression, and again distinct lines of a red or blue color, sometimes single, and at others two or three parallel ones. It is, however, extremely doubtful if a true ecchymosis or extravasation of blood ever results from compression of the neck by the cord; certainly there can be no abrasion of the cuticle, as is frequently observed in cases of strangulation by a rough string or cord. Even a livid mark around the neck is not necessarily caused by an effusion of blood, and such marks will often be found to disappear on the establishment of respiration. It should also be remembered that, in fat children especially, if the neck be short and the body has been kept in a cold place, furrows and ridges may be formed in the folds of the skin, which, to an ordinary observer, might be suggestive of strangulation.

Should a ligature be actually found around a child's neck, there could, of course, be no longer any question about the impression not being due to the umbilical cord. The usual defense in such a case is that the ligature was placed there by the woman herself, for the purpose of assisting her delivery, and no medical evidence can disprove such a statement. If the strangulation has been accomplished by the hand, the impression left will usually be very distinct and suggestive, and totally different from that produced by the navel string, which, at most, leaves a broad, smooth indenture, with soft edges.

The cord sometimes, by being coiled around the limbs

and body of the child, before birth, produces deep depressions in the skin. Even an amputation of a limb has been observed as an effect.

(2) Protracted delivery is not infrequently the cause of the child's death, especially in first labors. It may be ascribed either to congestion of the brain, resulting from the compression of the head, or to interruption to the circulation in the umbilical cord, through pressure, before respiration can be performed. In primiparous cases, the labor is very apt to be protracted, and the child large, often requiring the application of the forceps. In death from this cause, the head will usually be found much elongated, with evidences of considerable pressure, and having a large *caput succedaneum*. The autopsy will disclose congestion of the cerebral vessels.

(3) Debility.—A child may be born either prematurely or at full term, and soon die from constitutional weakness, either inherited or produced by causes acting upon it before birth. In such feeble children a very slight cause is sufficient to destroy life. Such cases are recognized by the immature condition of the body, and the absence of all other causes of death.

(4) Hemorrhage from the cord is sometimes the cause of death in the new-born child, either from accidental rupture during the birth, or after its severance. The sudden premature separation of the placenta will produce the same result. The child, under these circumstances, will exhibit a blanched and waxy appearance, together with a paleness and dryness of the internal organs, particularly of the heart and lungs. This will not, however, hold good where putrefaction of the body is advanced. The hemorrhage may be accidental, or the result of criminal design. In either case it may have

arisen from laceration of the cord, or from an omission to tie it after birth. Dr. Reese witnessed one case of fatal hemorrhage of the cord some days after birth, in spite of every effort to control it. Casper, with his large experience, states that he never met with a fatal case of hemorrhage of the cord, although he had witnessed several where it had been cut off close to the navel.

It would appear, from numerous cases reported, that fatal hemorrhage is less apt to follow when the cord is ruptured than when it is cut, probably for the same reason that a torn artery is less likely to bleed than one severed with a knife. According to Wharton and Stillé, it is the habit of the Indian squaws to break the cord, and then bind the fetal end with a strip of bark. Numerous instances are also mentioned of rapid delivery in women in an upright position, where the child has suddenly escaped from the mother and fallen to the ground, rupturing the navel string, yet without any bleeding of consequence. We know that the instinct of some animals leads them to divide the cord with their teeth, while in others it is ruptured either by the fall of the young while the mother is standing upright, or else by her suddenly springing up when delivered in a recumbent position.

The usual length of the umbilical cord is from eighteen to twenty inches; but it frequently exceeds this, in one instance amounting to fifty-nine inches and in another sixty-nine inches. In ordinary cases of delivery in the upright posture, the child may fall a distance of twenty-eight to thirty inches to the ground without putting a strain upon the cord. But in most instances of this nature this distance would be diminished by the woman instinctively assuming more or less of a bending position at the moment of expul-

sion. Still, it might happen that the cord might be unusually short, or else wound round the child, in which case it could easily be ruptured. The point at which the rupture usually occurs is a few inches from the umbilicus. In some instances of sudden traction, where it does not break, the placenta attached may be dragged out by the weight of the child.

(5) Fractures.—These are chiefly confined to the head of the child, and may be produced during any period of gestation, either accidentally or otherwise, from blows, falls, or other injuries, such as the kick of a horse, etc. Other bones may, of course, be fractured by blows, or injuries sustained by the mother during pregnancy. Sometimes when the result is not fatal to the child, the marks of bony union are visible after birth ; but in most such cases the child perishes at the time of the injury and is born prematurely, so that the question of infanticide hardly presents itself. Fractures of the skull may occur accidentally during labor, from a disproportionate size of the child's head, or some deformity or osseous tumor of the mother's pelvis. As such cases usually require instrumental aid, the injury may have been unavoidably caused by the forceps. Such fractures, however, are rare, on account of the extreme mobility of the cranial bones upon each other, which allows of considerable pressure and reduction of the volume of the head. In these cases, as the child may survive sufficiently long to breathe, it is of importance to prove that the fracture was accidental and not criminal. In the former case, the fracture is nearly always on the parietal bones, sometimes in the frontal, but never in the occipital bone. It is usually a mere fissure or crack, very rarely a depression, unless great violence had been employed. In cases of criminal violence, the fracture

would probably be stellated or depressed, the bones often being driven deeply in, and the brain even protruding, together with laceration of the scalp and other marks of violence. In a case in which the criminal fracture happened to be only slight, it might be impossible to distinguish it from one resulting accidentally at the birth. It should also be remembered that very extensive fractures of the child's skull may result from criminal violence, without any visible trace of injury to the scalp. There is also a possibility of mistaking a defective ossification of the bones of the cranium for fracture. This defect occurs usually in the parietal bones, and is caused by a deficiency in the bony spiculæ, which is replaced by a membrane that fills up the gap. The edges of the bones are thin and beveled, and show no marks of injury. A true fracture is evidenced by a red line, seen on removing the pericranium, by the edges of the bone being jagged and bloody, and by the absence of any membrane; there is also more or less effusion of blood in the neighborhood of a fracture.

The cases that occasion the greatest difficulty are those in which the fracture is alleged to have resulted from the fall of the child to the ground, in consequence of a sudden delivery while the mother was in the erect position. Such cases, although comparatively rare, occur sufficiently often to require attention. They present no special marks by which they can be distinguished from cases of criminal violence. Some writers deny the possibility of this accident, but others, including Casper, admit an occasional occurrence. Dr. Reese made experiments on the bodies of twenty-five dead infants, letting them fall from a height of thirty inches upon a hard pavement. One parietal bone was found fractured in sixteen cases; both parietals

in six cases; once the parietal and frontal; once the frontal; and once the occipital. The fractures, in most cases, occurred about the parietal protuberances. It should be remembered that it is easier to fracture the skull of a live infant than that of a dead one. So, also, it has been ascertained that when firm pressure by the thumbs and fingers is made upon the head of a new-born dead child, out of fifteen experiments, in seven long fractures of one or other parietal bones resulted; in the other cases the result was merely a depression of the bone. Hence, we must conclude that the possibility of such an accident should always be taken into consideration, in cases of concealed birth, when fractures of the skull are discovered.

2. *Causes of Death after Birth.*—These are both numerous and varied. (1) Congenital malformation and disease may exist; but in most cases life may endure, though for a brief period, even in monstrosities. Some of these malformations are remediable, others are not. If violence should be inflicted upon such beings for the purpose of destroying life, the evidences for its discovery are similar to those employed in other cases.

(2) Exposure.—Under this head may be included all the different cases of abandonment of the new-born child. The new-born infant quickly perishes if not properly cared for in the way of food and clothing. Authorities generally agree that deprivation of nourishment for over twenty-four hours is likely to prove fatal. Foderé states the greatest length of time to be one or two days. Yet there are cases on record where the infant survived three days without any food, and exposed, at the same time, to the variations of the temperature.

The proofs of death from exposure to cold are by no

means positive unless the body be discovered frozen stiff, discolored and shriveled, naked or scantily covered, in a cold place, buried under stones or earth, its lungs affording evidence of previous respiration, the internal vessels gorged with blood, while the external ones are empty, the brain deeply congested, as also the lungs and right heart (Foderé). Under such circumstances and in the absence of all causes of death it may be ascribed to cold.

The signs of death from starvation are to be sought for in the same general way. These are an emaciated and shriveled body; a pale and wrinkled countenance, expressive of pain; dry, tough, and yellowish skin; the mouth, tongue, and fauces also dry; the stomach and intestines empty and contracted; gall bladder enlarged and bile usually found in the alimentary canal; stomach inflamed in places; the heart flaccid and the great vessels almost empty. Cases of infanticide by absolute starvation are rare. In order to establish the charge, it must be shown that the woman willfully kept the child without food, and with a criminal design. Mere neglect or imprudence is not sufficient. In a suspected case of this kind, it is recommended to examine the contents of the stomach for starch and other varieties of food.

There is no doubt that many young children are purposely exposed to the danger of starvation by putting them out to be nursed on improper as well as scanty food, as witnessed in the wretched system of baby-farming.

(3) Wounds and Injuries.—These are frequently the cause of death in new-born children; they usually prove rapidly fatal, and, as a rule, leave no signs of inflammation or its results to indicate that the wound was made during life. The best evidence of the ante-mortem character of the

wound is the presence of coagula under and around it. These indicate that the circulation was going on at the time; but if the effused blood be liquid, the presumption is that the injuries were inflicted after death, and while the body was yet warm. An accidental wound upon the child (usually on the arm or leg) might be made by the knife or scissors employed in cutting the cord; but in such a case there should be proof that the cord had been really cut, and not ruptured.

Penetrating and punctured wounds, of apparently trifling character, may easily prove fatal to a new-born child. Thus, punctures made by a needle or stiletto into the fontanelles, between the vertebræ or under the orbit, are almost sure to destroy life. Beck mentions the case of a midwife who was executed in Paris for killing several children by plunging a needle into the head as it presented itself at the mouth of the womb. He also cites the case reported by Dr. Underwood, of a child who died in convulsions which could not be traced to any cause until after death, when a pin, that had accidentally gotten under the child's cap, was found inserted into the fontanelle. The cause of death in such cases may easily escape detection. If suspected, the skin should be carefully dissected off and spread out before the light, when the finest puncture can be detected.

Dislocation and fracture of the neck (*twisting of the neck*) are occasional causes of death in new-born children. Of course, in such cases the defense would ascribe it to accident in the efforts to disengage the child from the mother, and the fact of criminal interference could only be established by the attending circumstances. It should also be remembered that cases are recorded where other dislocations, as of the hip and knee, have taken place before birth as the results of an injury to the mother.

(4) Asphyxia in its various forms is the most common of all the means of destroying the new-born child. According to M. Tardieu, whose ample experience extended over twenty-four years, four-fifths of all the cases of infanticide that he had examined were due to some form of asphyxia.

Asphyxia may be effected in various ways—as by suffocation, strangling, hanging, or drowning, by smothering under the bed-clothes, by exposure to noxious vapors or gases, or by thrusting various substances into the mouth and nose.

(*a*) *Suffocation.*—This is a frequent cause of accidental death in new-born children, arising from neglect to remove it from the maternal discharges or from the bed-clothes, or to disengage its face from the membrane, or *caul*, which is sometimes spread over it, or to remove the mucus from its mouth and throat. In some cases the obstruction is caused by meconium, blood, or feces which have been taken in by aspiration, in the passage of the head through the outlet, or immediately after birth. Such instances of accidental suffocation usually occur when the woman is delivered without any assistance.

Suffocation is a very frequent criminal cause of death in cases of infanticide. The facility with which it can be accomplished, and the slight risk of detection, in consequence of the difficulty of distinguishing it from an accident, doubtless cause it to be so often resorted to. A wet cloth simply placed over the mouth or thrust into the cavity, either before or after respiration, and pressure on the child's chest (though the latter might accidentally occur at birth, when the head is born and the body is retained for some time and subjected to pressure in the outlet), foreign bodies

introduced into the mouth and throat, such as tow, hay, feathers, ashes, etc. Such are the means commonly employed for suffocating the child. In one case a mass of dough had been forced down the throat so as to obstruct the larynx; in another, the back part of the throat was packed with wet sand; and in a third, the respiratory passages were filled with cinders, drawn in suddenly by aspiration. A child may also be suffocated under the bed-clothes, or by exposure to the noxious vapors of sulphur, burning charcoal, the exhalations of privies, etc., and without leaving any trace of the real cause of death.

Strictly speaking, the child cannot be said to be suffocated unless it has first breathed; yet in many cases the death is brought about before respiration is established—breathing is simply prevented. Under such circumstances it would be impossible for the examiner to ascribe the death to a criminal act, unless there existed very evident marks of undue violence. In every case of infantile suffocation, a careful inspection of the respiratory openings should be made, in order to detect the presence of foreign bodies. In true cases of suffocation the post-mortem signs are those of apnea generally—such as congestion of the right heart and venous system, and also of the brain; but there are present, also, the punctiform ecchymoses under the pleura, pericardium, endocardium, peritoneum, and bronchi, so much insisted on by Tardieu. The lungs of infants, according to the best authorities, are not usually found engorged with blood. Tidy says: "If the child be vigorous and well developed, the muscular and elastic forces of the arteries and arterioles will be sufficient to drive the blood on after the heart has ceased to beat and respiration is prevented. Such lungs will, therefore, be found comparatively bloodless

or anemic, but with a large amount of emphysema, or dilatation and rupture of the air-cells, owing to the violent attempts at inspiration or breathing."

If the death has resulted from pressure of the body under the bed-clothes, the head will be found flattened, the tongue protruding, the eyes half open, a frothy mucus escaping from the corners of the mouth, and the excrements voided.

(*b*) *Strangulation.*—This is a not infrequent mode of child-murder. The marks differ according to the methods employed. Since, in criminal strangulation, much more violence is usually employed than is necessary, the neck will be very apt to bear the impress of the fingers or of the ligature employed, and sometimes of both. At times there may be abrasion of the cuticle from the roughness of the ligature, and also ecchymosis surrounding the marks of the latter.

In all such cases of infanticide, the usual defense set up is that the cord was placed upon the neck of the child to aid in its delivery; or else it will be attributed to the accidental encircling by it; this, however, would be disproved by the evidence of breathing. Even the marks of the fingers upon the throat, indicating throttling, will be attempted to be explained by referring them to the same cause.

The question whether the marks of the cord in strangulation can be imitated if it is applied after death, must be answered in the affirmative, provided it is done very soon after death, and while the body is yet warm.

The only difference between strangling and hanging, as a mode of child-murder, is the oblique mark of the cord about the neck of the latter. Hanging is certainly a very rare form of infanticide.

(*c*) *Drowning.*—There are no signs to indicate death from drowning in the body of a child that has not breathed ; yet this form of infanticide has been known to be perpetrated criminally, as when a woman causes herself to be delivered in a bath, so as to retain the child under water, and thus prevent its breathing. After respiration, the signs of drowning are the same as in adults. Here the important medico-legal question is, Was the child alive or dead when thrown into the water ? Generally it is the latter ; hence the importance of an accurate inspection of the body to ascertain the existence of marks of violence, some of which would be positive evidence of antecedent death, while others might possibly be ascribed to accidental causes. In all such cases the throat and air passages should be especially investigated for foreign substances.

It should be remembered that a young infant may easily be drowned by the simple immersion of the face in water. Cases have occurred where, through unconsciousness, or in a very rapid delivery, the child is projected into a commode half full of water, where it would certainly perish by drowning if not soon rescued. A case of this nature—which did not, however, result fatally—occurred in the practice of Dr. Reese. The accident may happen to a woman mistaking the sensation caused by the pressure of the child's head on the perineum for the feeling of a desire to evacuate the bowels. Yielding to this impulse, and sitting upon the opening of a privy, a sudden pain will eject the child from the maternal parts, and in its fall the umbilical cord will be ruptured, or else, in rare cases, the placenta may be dragged out still attached, and the child will miserably perish. Cases of this sort occasionally occur, and it is extremely difficult, if not impossible, to

distinguish these from cases of criminal infanticide, since they will both exhibit the same evidences of death from suffocation. In a criminal case, however, the accompanying circumstances may sometimes lead to the detection of the culprit, as when marks of blood are discovered in her bed-room, which may, perhaps, be traced to the privy; or when the umbilical cord may be discovered cut and not ruptured; or other circumstances be presented which would render the prisoner's account inconsistent with the theory of the accident.

(*d*) *Poisoning* is an extremely rare form of infanticide, although it is a frequent mode of destroying young children. One case is recorded of poisoning a child one day old with arsenic; the mother was acquitted upon the plea of puerperal insanity.

The following general conclusions may be considered as warranted from the foregoing considerations: (1) Did the death occur naturally? (2) Could it have been prevented? (3) Is the mother guilty of not having used proper precaution? (4) Was the death caused by violence on the part of the mother? (5) If there are marks of violence upon the child, did the mother inflict them?

From what has been said upon this subject, it is evident that medical testimony is not always sufficient of itself to establish a charge of infanticide. So many cases, as we have seen, occur in which precisely the same medical signs are exhibited in both accidental and criminal death in newborn children, that the attending circumstances have to be depended upon in order to come to a decision.

MODE OF CONDUCTING AN EXAMINATION IN A SUSPECTED CASE OF INFANTICIDE.

1. *External.*—A careful external inspection of the body of the child is first to be made. Note the color, sex, length (measured from vertex to feet), the presence or absence of putrefaction, wounds, bruises, injuries, stains, etc. Take the dimensions of the thorax, shoulders, and head; also ascertain the weight and the centre of the body, and note the condition of the umbilical cord.

2. *Internal.*—Observe the shape and condition of the thorax; the lungs, as to their position, volume, shape, and color; their absolute and specific weight; the position of the diaphragm; the condition of the heart as to the foramen ovale and ductus arteriosus; also the ductus venosus and the umbilical vessels. In the abdomen, observe the stomach and intestines, the liver and bladder. Also notice the brain and spinal marrow.

The Autopsy.—The first incision should be made commencing at the centre of the lower jaw, and extending to the lower end of the sternum. Some advise to divide the lower jaw at the symphysis, so as the more completely to expose the buccal cavity, in the search for foreign substances; this, however, may not be necessary. The position and appearance of the tongue are to be specially noticed. The larynx and trachea are next to be laid open, and as much of the esophagus as can now be seen. The incision is now to be carried down on each side of the spine of the ilia, and the triangular portion of the integuments thus shaped out is to be turned back, so as to examine the condition of the umbilical vessels. The abdomen is next to be opened, and the position of the diaphragm noticed.

All the viscera are to be carefully inspected, together with the *ductus venosus*, behind the liver. The stomach and bowels are to be tied and removed in order to search for poison, if suspected. The gall bladder and urinary bladder should be examined; also the presence or absence of meconium in the large intestines be ascertained.

The thorax should be opened with the scissors, preferably to the knife, at the junction of the costal cartilages. After examining the general appearance of the contents, all the great vessels are to be tied, and divided beyond the ligatures; the trachea is also to be divided at its root. The lungs are then to be taken out and weighed, and subjected to the hydrostatic test. The heart may now be examined as to the condition of the *foramen ovale* and *ductus arteriosus*. The head may be examined by making one incision from the root of the nose back to the neck, and another at right angles from ear to ear; strong scissors should be used in cutting through the bones. The brain is to be removed and inspected in the usual manner. The spinal cord will often require examination, and sometimes also the vertebræ.

The other two questions pertaining to the infant, in a case of child-murder, have reference to its age and the interval elapsed since its death. The age of the new-born child is to be determined by ascertaining if it exhibited the recognized character of a fully matured fetus. The exact interval of time that has elapsed since its death cannot be determined merely by a medical inspection. Many circumstances would have to be considered, such as the season of the year, the temperature, the place where the body was discovered, etc., before the examiner could venture an opinion; and he should always be extremely cautious in

the matter, seeing how uncertain are the signs on which that opinion is to be founded.

It is necessary in every case of alleged infanticide to connect the condition of the reputed mother with that of the infant, so as to establish the fact that she has been actually delivered about the time when it is judged that the child was born. This is easy, in a recent case, if the mother is willing to submit to medical examination, but it is altogether different when a considerable interval has elapsed since the birth.

The question, then, is, Has the woman under examination been recently delivered? If the examination is made within three or four days after delivery, the following signs will usually be exhibited: there is more or less weakness, some pallor of face; the eyes a little sunken, with a dark areola under or around them; the skin is soft, moist, and relaxed; the whole aspect resembling that of a person recovering from sickness. The pulse is soft and a little quickened; the abdomen feels soft and relaxed to the touch, and is sometimes thrown into folds, and presents, on the surface, a number of transverse, livid lines, which, at a later period, become white and shining, or silvery (*lineæ albicantes*). The uterus can be distinctly felt through the wall of the abdomen, low down, like a large ball. The breasts have a full and somewhat knotted feel; they are generally enlarged, and the nipples are prominent and often exude a watery milk.

The external organs of generation are swollen, relaxed and moist; the vagina capacious, and without folds; the *os uteri* easily felt to be low, and somewhat patulous; the lips soft and relaxed, and, perhaps, slightly lacerated. The uterine sound will show the increased depth of the uterine

cavity, and prove the tumor felt from the outside to be the womb. There will be a dark, muco-sanguinolent discharge from the uterus, known as the lochia, readily distinguishable by its peculiar odor. The color of the lochia subsequently becomes much lighter, or greenish ; this discharge usually disappears in a week or ten days, and in some instances it is suppressed.

These signs combined form very satisfactory proof of delivery, although none of them can be relied upon singly. The condition of the genital organs affords the most conclusive evidence.

The *lineæ albicantes* may result from any distention of the abdomen, as ascites, uterine tumor, etc. ; they have even been seen in the male. The secretion of milk may be absent, and, again, it may occur in the unimpregnated condition ; but the presence of colostrum among the milk corpuscles (to be determined by the microscope) may be regarded as conclusive evidence of a recent delivery. The lochia and the relaxed state of the genital organs might be mistaken for the catamenia, except for the peculiar odor ; but the jagged or notched condition of the *os uteri* and its patulous state are usually to be attributed to a recent delivery.

All the above signs of delivery fail completely after the lapse of five to ten days, except the still increased size of the uterus, and its rather open and jagged mouth, together with the silvery lines across the abdomen. The two last mentioned signs would be positive evidence, provided this could be shown to have been the woman's first pregnancy, and provided, also, the absence of any other abdominal swelling could be proved. Otherwise, they only afford grounds for suspecting one or more former deliveries.

Signs of Delivery in the Dead.—Supposing the woman to have died immediately after her delivery, the evidences of that fact will be sufficiently manifest. Besides the condition of the external organs above described in the case of the living, on opening the abdomen the uterus will be found flat and flaccid, between nine and twelve inches long, and with the os wide open. The cavity will contain bloody coagula, with the remains of the decidua lining the inner surface. The attachment of the placenta will be marked by a gangrenous-looking spot. If the death has been delayed only a few days, the womb will be considerably modified; and if three or four weeks have elapsed, it will be as difficult to determine delivery in the dead as in the living.

The fact of unconscious delivery must be admitted, as it is supported by positive evidence, and as it is in accord with the well-known instances of a similar character in women when in coma, epilepsy, asphyxia, narcotism, and anesthesia from ether and chloroform, and also when in profound natural sleep.

Concealed Delivery.—In nearly every case of infanticide, it is the object of the woman both to conceal the body of her child and hide all traces of her delivery. The concealment of pregnancy is no offense in law, but the concealment of delivery or of the birth of a child is a misdemeanor. As a matter of fact and practice, however, women who are tried on this charge are punished, not for concealment of the birth, but for concealment of the body of the child—a distinction which excites hope in the criminal that if she can do away with the body she may be free of the law. According to statute, the child must be dead; the concealment of a living body is no offense, unless it should happen to

die before the birth was made known. In a trial for concealment of birth, the medical evidence is derived exclusively from the mother; the body of the child need not be produced, and the special points which will engage attention are (1) the proofs of recent delivery; (2) the proofs of previous pregnancy, and (3) the connection between the alleged period of delivery and the state of the child as found.

Pretended Delivery.—This occasionally occurs for various motives, and sometimes without any assignable motive. A medical examination will detect the imposture, because the assumed delivery must be recent and not remote. The pretense may occur when the woman has never been pregnant, when she had been pregnant, and when she had been delivered, but had substituted a living for a dead child.

Evidences of the Death of the Child before its Birth.—The question whether the child is dead *in utero* may require to be determined in certain civil cases involving succession to an estate, contingent to the life of the child; also in criminal cases—as where a pregnant woman has been maltreated, and her unborn offspring is alleged to be dead. During pregnancy, the life of the fetus is inferred from the general good health of the mother, although this is by no means a positive sign. The progressive increase in the size of the abdomen, together with the continuance of the fetal movements, though strongly suggestive of fetal life, are not absolute proofs. The only unequivocal sign is the sound of the fetal heart repeatedly heard by auscultation.

The indications of the death of the fetus during pregnancy are the cessation of all motion, after this has been positively felt by the woman. She experiences a sensation of a dead weight in the abdomen, along with a sense of

lassitude; the breasts are apt to recede, or become less prominent; there is pallor of the countenance, with a dark circle around the eyes; the spirits flag, amounting at times to melancholy; the breath is fetid. While these signs combined may excite a strong suspicion of the death of the embryo, the only positive and unequivocal proof of it would be the ascertained continuous absence of the beat of the fetal heart by means of the stethoscope. It is stated, on good authorities, that the placental murmur may continue some time after the death of the fetus.

During delivery the signs of the child's life are limpidity of the waters, regularity of the pains, with increase in strength, pulsation of the cord, heart, and fontanelles.

Putrefaction of the fetus generally occurs soon after its death *in utero*, and it is usually prematurely expelled within a few weeks; but occasionally it is retained until the full term, and may even then not exhibit the marks of decomposition. The various causes that may occasion the intra-uterine death of the child have already been described.

The indications of the child's death during delivery are fetid discharges instead of limpid waters, absence of all motion, a livid appearance of the skin, no pulsation of the umbilical cord, the cuticle peeling off the head in flakes, and the bones of the cranium loose and floating. The lividity of the skin is not an invariable sign; a case is mentioned in which, in an arm presentation, this member was so livid and cold as to be supposed certainly to indicate the child's death; it was consequently amputated, in order to facilitate the labor, but to the discomfiture of the obstetrician, the child was born alive and survived.

The general appearance of a fetus that has been dead some time before its birth has already been described.

CHAPTER XI.

LEGITIMACY—INHERITANCE.

THE question of **Legitimacy** is one involving the nearest and dearest interests of social life, and one at times surrounded with no slight difficulties arising from the uncertainty of most of the evidence usually advanced.

Cases involving the question of legitimacy are rarely decided upon medical evidence alone; there are usually circumstances which indicate the parentage of the child whose legitimacy is disputed. The important point for consideration of the physician is the duration of gestation.

The following positions may be considered as settled by the laws of this country and England:—

I. Every child born in wedlock is presumed to be legitimate, unless it can be shown (1) that the parties had been separated for a time beyond the period of gestation; (2) that the husband was impotent; (3) adultery on the part of the wife and the repudiation of the alleged child by the husband. When the woman was so far advanced in pregnancy at the time of her marriage that her situation must have been known to her husband, this will be deemed as a recognition of paternity, and also of legitimacy, on his part.

A child born after the death of its father or mother (as by the Cæsarean section) is held to be legitimate, although, strictly speaking, the marriage tie is dissolved by death; hence, as remarked by Taylor, a child may be conceived

before marriage, and born after the death of the mother or father, and yet be legitimate, although neither conceived nor born in wedlock.

Duration of Gestation.—The usual popular notion upon this point is that it comprises nine calendar months (273 to 275 days), or ten lunar months (280 days). Ten lunar months was the period allotted by the Roman law, which was also the opinion of Harvey, dating from the commencement of the last menstrual period. There seems to be a fair physiological presumption for this latter view, based on the idea that parturition occurs at the period of what would be the tenth menstrual effort since the last.

The discordance existing on this subject arises partly from want of a definite starting-point. This is usually fixed by the woman by certain peculiar sensations supposed to be experienced at conception or at the period of quickening. The first is altogether fallacious, for conception may occur in the unconscious state. The second is equally uncertain, since the time of quickening varies so much in different women,—from the twelfth to the twenty-fifth week; and in some it is not perceptive at all, whilst in others it may be supposed to exist even in the absence of pregnancy. The cessation of catamenia is the usual and the surest method of calculating, but it is liable to many fallacies, such as the arrest of the menses before pregnancy; their continuance for a month or more after pregnancy, and the intervals between the periods not being the same in all women. Usually there is an interval of twenty-eight days from the commencement of one period to the commencement of another, but it is frequently longer or shorter, and this in the same woman at different times. As conception

may take place at any period of the interval between the catamenia, it is evident there might be a difference of twenty-three to twenty-five days as to its actual date, according as it occurred immediately after the one catamenial, or immediately before the succeeding period. The usual custom among married women is to reckon nine calendar months from the last-mentioned period, and to add about fourteen days for possible error. There is a diversity of opinion among obstetricians of the highest reputation on the subject of the natural period of gestation—varying from 274 to 301 days. It may be assumed that the average period is between thirty-eight and forty weeks.

The most certain and positive starting-point from which to fix the date of conception is a single intercourse. Even where this can be accurately settled, still there will be found considerable discrepancies which must be attributed to individual peculiarities, and which indicate that there is no absolute law on the subject. Observation shows periods varying from 233, 249, and 260 days, up to 293 and 313 days. Even rejecting the two extreme cases of 233 and 313 days (though they are perfectly authenticated), as very exceptional, we still have the great variation of forty-four days between the two extremes of 249 and 293 days, or of sixty days between the extremes of 233 and 293 days. Taking the average of fifty-six cases, dating from a single coitus, reported by various authors, ranging between 260 and 296 days, it will be found to be 276 days.

The irregularity as regards the normal period of gestation in the human female finds its analogy among the lower animals. Extended observations made upon the cow, the mare, and the sheep confirm the results observed in the human female. In the cow the average period of gestation

is about 285 days; yet, from Dr. Krahmer's tables, it is found that, out of 1105 cows, 335 calved on the fortieth week, 429 on the forty-first week, and 135 on the forty-second week; the balance varied from the thirty-eighth week to the fifty-first week—a period of about 90 days.

In *sheep*, the average time among 177 births examined was 150 days; yet the period varied from 145 to 171 days—a difference of 26 days.

In *mares*, whose normal term of gestation is about 300 days, Tessier found, out of 102, that 21 went as far as 360 days and one as far as 394 days.

The logical conclusion from the above statements must be that it is possible for human pregnancy to be prolonged beyond the usually admitted normal period; but the question how far beyond is rather difficult to answer; though the greater the amount of deviation, the stronger and more convincing should be the proofs.

It is an error to suppose that a protracted pregnancy is accompanied by an increased size of the child, although, physiologically considered, the fetus ought to continue to increase in size *in utero* after the usual term of gestation.

The celebrated Gardner Peerage Case well illustrates many of the above points. Lord and Lady Gardner parted from each other on January 30th, 1802. The husband returned on July 11th of the same year. During his absence, his wife was known to be living in adulterous intercourse with a Mr. Jadis. She was delivered of a son on the 8th of December, three hundred and twelve days after Lord Gardner's first absence and one hundred and fifty days (about five months) after his return. The child was perfectly developed and mature at its birth, so that

the idea of a premature birth was not entertained, and the only question was as to the possibility of a protracted gestation. The ablest obstetrical experts were engaged on both sides at the trial, and, as usual, there was a difference of professional opinion upon the subject, some maintaining that the period of gestation was absolutely fixed, while others (the majority) admitted the possibility of its being protracted. The case was decided against the claimant (the alleged son), not, however, on the ground of the protracted period of his birth, but on the ground of his mother's notorious adultery and her concealment of his birth.

A circumstance often lost sight of in this discussion is that conception is not always synchronous with intercourse or insemination. The former occurs only when the spermatozoids come in actual contact with the ovum. This may take place in the uterus or in the Fallopian tube, and several days may elapse after intercourse before it is actually accomplished. The spermatozoids are known to retain their vitality for a period of several days within the vagina; and as fecundation cannot result until these meet, the matured ovum (which requires a variable period for its descent from the ovary), conception might be delayed as long as seven days. This does not explain the lengthened variations of gestation above noted. As Taylor remarks: "We must be prepared to admit either that conception may, in some cases, be delayed for so long a period as five to seven weeks after intercourse, or that there may be a difference of from five to seven weeks in the duration of pregnancy." Winckel states that a pregnancy may vary from 240 to 320 days and even exceed the latter limit. Nearly seven per cent. of the cases are over 300 days.

II. *Premature Birth.—Diminished Period of Gestation.—Early Viability.*—An important question in connection with Legitimacy is, whether a child, in all points fully developed, can be born before the ordinary period of gestation? Its bearing upon the subject of Legitimacy is direct and important. For instance, a husband, after a long absence, returns to his wife, and a fully developed child is born after seven or eight months: Is this a legitimate child? The question is about as difficult to determine as the former one concerning a protracted pregnancy. It must be admitted that children at full term differ extremely in size, weight, and in apparent maturity, so that some eight months' children may appear better developed than some at nine months. This, however, is the exception and not the rule. Again, it is known that some women always give birth to their children before the full term; but these may be regarded as cases of diseased action. The probabilities are strongly against it.

Again, since in cases of prolonged gestation the children do not continue to grow *in utero* after their full period, it would seem still less probable that, in the earlier months of fetal existence, they should be one, two, or three months in advance of their normal intra-uterine life. Dr. Montgomery states that he never saw a seven months' fetus present the remotest appearance of the fully matured child.

It seems, therefore, that while in some instances there may be a doubt about an eight months' child, on account of its advanced degree of development, there ought to be no doubt whatever in the case of a six or seven months' child. The peculiar characters presented by the fetus at these ages have been given.

In an English case, in which the question of the legiti-

macy of a child was made to depend upon the period of the mother's gestation,—259 days, or 37 weeks (or three weeks lacking maturity),—Simpson gave evidence that a child born, perfectly matured, three weeks before the usual term, could not be legitimate. This is certainly stronger ground than many would take. To stamp a child as a bastard, and to impute the crime of adultery to the mother, because of the three weeks' prematureness of the birth, even though apparently mature, is an assumption not warranted by numerous facts.

As regards the earliest viability of a child, or the earliest period of intra-uterine life at which it is capable of living, there is a universal admission that an eight, or even a seven months' child may survive; that occasional instances have occurred where a six months' infant lived; and that a very few exceptional cases have been recorded of the survival of children born a little over five months. An infant born earlier than this period could not be considered viable.

The question of premature birth may present itself under a civil aspect, that of survivorship, when a living child acquires civil rights—such as inheritance and the transmission of property. In such a case it becomes a matter of vital importance to establish the fact that the child, when born, was actually alive. The laws of this country and of England do not require that the child should be viable, *i.e.*, capable of continuing to live, but only that it should be born alive. It matters not whether it be mature or immature, so that it was alive.

What, then, constitutes a live birth? Anything that will prove that the child was living at the time of its birth. According to the laws of the United States and England, neither breathing nor crying are essential to establish a live

birth; the pulsation of the child's heart, or of one of its arteries, or the slightest voluntary movement, is regarded as sufficient for this purpose. In Scotland, crying is regarded as essential; in France, respiration; and in Germany, crying, "attested by unimpeachable witnesses." According to Blackstone, crying, indeed, is the strongest evidence, but it is not the only evidence: and Coke remarks—"If it be born alive, it is sufficient, though it be not heard to cry, for peradventure it may be born dumb."

With this clear and definite understanding of what is legally regarded as the proofs of a live birth, we must admit that fetuses have been born alive as early as four months, and, of course, at all periods of a later date. Such a case is reported by Dr. Erbkam, of Berlin, in which the fetus was only six inches long and weighed but eight ounces; it survived half an hour; it moved its legs and arms, turned its head from side to side, and opened its mouth. Müller pronounced this fetus to be not over four months old. Dr. Barrows, of Hartford, reports another case, especially interesting from the fact that the exact period of conception could be fixed; miscarriage took place at 144 days—less than five calendar months. The ovum was expelled entire. Before rupture of the membranes, the movements of the child were vigorous. After the rupture it cried out very distinctly; the cord was tied on ceasing to pulsate, after which it breathed with a gasp for forty minutes; it repeatedly opened its mouth and thrust out its tongue. It measured ten inches long and weighed fourteen ounces.

Tenancy by Courtesy.—This phrase signifies, according to Blackstone, "a tenant by the courts of England,"

and is applied to the case in which a husband acquires a life-interest in the property of his wife at her death, provided a child was born of the marriage, living, during the wife's life. "In this case" (in the old law language) "he shall, on the death of his wife, hold the lands for his life, as tenant by the courtesy of England." If there should be no living issue, the property would pass to the heir-at-law. In every such case the following conditions must be settled: (1) There must be proof of a live birth. We have already adverted to the proofs required to establish a live birth in different countries. (2) The child must be born while the mother is living. This was the old dictum of Lord Coke some three hundred years ago. Hence, if a living child were extracted by the Cæsarean section from a dead mother, it could not transmit an inheritance. It is not certain that this doctrine would be followed by modern courts. (3) The child must be born capable of inheriting; therefore, a monster cannot inherit or transmit a property. It is difficult to give a legal definition of a monster. Clearly, no mere external deformity or internal malformation would constitute such a disability. Lord Coke defines a monster as "a being that hath not the shape of mankind." Thus, an acephalous, dicephalous, or disomatous creature would seem to be excluded. St. Hilaire's distinction in relation to such beings is usually followed, viz., to consider every monster with two equally-developed heads, whether disomatous or not, as two distinct beings; and every monster with a single head, disomatous or not, as only one being. It is difficult to say how such a ruling would apply as to the exclusion of the Siamese twins and other similar cases. In several of our own States, the old English law of the "Tenancy by Courtesy" still prevails. Dr. Reese

was once called as an expert, in the State of Delaware, to determine the fact of the live birth of a child which had neither breathed nor cried, but whose heart and temporal arteries had pulsated for several minutes after birth. One of the parties to the suit adopted the usual course in such cases, namely, to assert that these acts of the circulation were only the remnants of uterine life, and could not be considered as evidences of an independent life on the part of the infant; but it was conclusively shown that every action of a person's life may, in one sense, be regarded as the remnant of uterine life, and that, as such acts could not be performed by a dead child, the only alternative was to admit that it was alive. Moreover, several cases were cited, both English and American, in which the live birth was sustained on much slighter proofs than the above.

Laws Concerning Legitimacy.—The Roman law did not consider a child legitimate if born later than ten calendar months after its father's death. The French law allows the legitimacy of a child born 180 days (or six calendar months) after marriage, and 300 days after the death or non-access of the husband. The Prussian law declares a child legitimate that is born within 302 days after the husband's death. In Scotland, the legitimacy of a child is established if it is born 168 days (six lunar months) after marriage, and within ten months after the death of the husband. In the Jadine case, the General Assembly of the Church of Scotland pronounced in favor of the legitimacy of the child, which was born 174 days after marriage.

In this country and in England there is no law regulating the exact period of gestation in relation to legitimacy, each case being decided on its own merits. In the United States,

in one instance, legitimacy was allowed where the time was 317 days; and in another case, affiliation was allowed where the period was 313 days. In England it was disallowed when the time was 311 days (Gardner Peerage Case); but, as was remarked above, the moral circumstances of this case, rather than the question of a protracted gestation, influenced the decision.

Minority and Majority.—In law the word minor or infant signifies a person under the age of twenty-one years. Before this age, he or she is regarded as incapable of performing certain civil acts, such as serving on a jury, making a will, executing a deed, or other contract. The law has fixed no age for competency as a witness, the court judging, in individual cases, of the mental capacity of the child. It is usually held that a child up to seven years is incapable of distinguishing right from wrong, and is, therefore, legally incapable of crime. At fourteen a child is considered to have arrived at years of discretion, and it then becomes responsible for its actions, as for murder or rape.

A person attains legal majority the first instant of the day before the twenty-first anniversary of his or her birthday, although forty-seven hours and fifty-nine minutes short of the complete number of days, counting by hours. This is on the principle that the law takes no account of part of a day. Hence the importance of noting the exact day and hour of a child's birth, as a few minutes or hours may thus determine the attainment of majority.

The date at which minority ceases is subject to determination by statute, and hence the rule may vary in different States, and a different age may be fixed for each sex.

Paternity—Affiliation.—The question of *Paternity* may present itself under various forms; as, when a woman marries a month or so after the death of her first husband, and a child is born in about ten months afterward; also when a supposititious child claims to be heir of an estate; and still more frequently, in cases of bastardy, when the putative father is obliged to support the child. In all such cases likeness to the parent is regarded as strong presumptive proof of paternity, requiring, however, further corroboration. This paternal resemblance extends not only to the features, but also to the voice, gesture, attitude, and habits.

Paternal likeness may obviously be shown by color, as where a white woman gives birth to a mulatto or Mongolian child, or *vice versa.*

Personal deformities are sometimes, though not always, transmitted from parent to child; but, certainly, it would not be safe, in a disputed case of paternity, to make the decision solely to depend on this. In some alleged cases of this nature, it is quite possible that the mind of the woman, while pregnant, might have been influenced by the mere sight of the deformed man alleged to be the father of her child.

In the Douglass Peerage Case this question of paternity was the turning point as to whether the claimant, Archibald, was the true and lawful heir to the title and estate. The case was tried in 1767, in the Court of Session, in Scotland, and lasted eight days. Out of fifteen judges, eight decided against the appellant. The case was then appealed to the House of Lords, which reversed the former decision. Lord Mansfield delivered the judgment, and took occasion to express a very decided opinion in favor of the

parental likeness which the claimant bore to his father as constituting an important link in the chain of evidence.

A case of affiliation may present itself in which a child born of a woman who has had intercourse with two men within a few days of each other is affiliated upon one of the men rather than upon the other. Here it would be impossible to settle the question by a mere medical opinion. The circumstances of color, or other likeness, or some accident, might assist in determining the question.

Connected with the question of paternity there is a curious physiological fact that might occasionally be supposed to affect the decision. It is known to breeders of horses and cattle that the influence of the impregnation by one sire may be extended beyond the foal begotten at the time and affect those begotten subsequently by another sire. This is proven by the later colts or calves bearing the peculiar markings of the first sire. The question, therefore, might be suggested whether this same handing down of parental likeness to the children of a subsequent father might be possible? Without any positive data on which to venture an opinion, it may, nevertheless, be suggested here as a circumstance to be considered in certain cases of affiliation.

Superfetation.—By this term is implied the conception of a second embryo in a woman already pregnant, and the birth of two children at one time differing considerably in their maturity, or of two births at different times of mature children. The possibility of a second conception after a successful impregnation is denied by some authorities; but the proof of it is abundantly established by the fact of a woman giving birth to two children of different colors, and her admitting to have had intercourse with a white and a

black man successively. It must also be accepted as possible in the case of a double uterus. The usual explanation given by those who reject the doctrine is that there was a twin conception, and that one of the embryos became blighted in early uterine life while the other continued to be developed. This explanation may cover some cases of alleged subterfetation, but certainly not all, as when two perfectly mature children are born three or four months apart, and especially when two children of different color are born together, or one soon after the other.

It has been maintained that superfetation is impossible, because of the physical obstacle to the entrance of the seminal fluid into the mouth and neck of the uterus caused by conception. This, however, has been denied by Dr. Duncan, who has shown that the mouth of the womb is not immediately closed after conception, and that communication between the vagina and ovary is not cut off for several months after impregnation, and that there is no impediment to the ascent of the spermatozoids. Others attribute the rarity of superfetation, not so much to any mechanical impediment, as to the absence of proper ovules, ovulation being of rare occurrence in the pregnant condition.

Double conception has been observed in the lower animals, as in a mare covered successively by a horse and an ass: she produced at the same birth a horse and a mule.

The result of all the observations made upon this subject is, that the majority of the alleged cases of superfetation may be explained (1) upon the theory of twin pregnancies, where one fetus has grown at the expense of the other, and is first expelled, the other remaining until it has acquired the proper maturity; (2) by the existence of a double uterus. Nevertheless, there are a few other cases

which do not admit either of these explanations, and which cannot be accounted for except on the theory of two successive conceptions.

Doubtful Sex—Hermaphroditism.—The latter term strictly applies to those cases in which the organs of both sexes exist in the same individual ; but it is now commonly employed to designate all cases of doubtful sex. With the defective sexual development there are usually associated certain peculiarities which indicate the preponderance of the characteristics of one sex. Until the period of puberty it is often difficult to determine the particular sex of the individual. At this epoch, however, certain changes usually occur that show the preponderance of either the male or female sex, such as change of voice, greater development of the shoulders or hips, the appearance of a beard, the development of the breasts, etc. The mere absence of testicles does not prove that it is not a male, since the testes sometimes never descend into the scrotum. Neither does the presence of a beard and whiskers necessarily indicate that it is not a female. Women have been seen with as flowing a beard as is found on most males. In some cases an external examination may fail to indicate the sex ; the clitoris may be mistaken for the penis, the labia for the scrotum, and the prostate gland for the uterus. Even a post-mortem examination may not always succeed in clearing up the uncertainty.

Important medico-legal relations may have to be determined in cases of doubtful sex. Such beings, on account of imperfect sexual development, may be impotent and sterile, hence questions of divorce, legitimacy of offspring, paternity, and affiliation may be raised. Such beings cannot

be deprived of the right of inheritance, nor in the United States of the right of voting, if medical testimony shows a preponderance of the male peculiarities. In case of inheritance depending upon the sex of the offspring, when the estate and title descend to the first-born male, if the offspring should prove to be of doubtful sex the preponderance of the male peculiarities would have to be clearly established by a medical examination before the inheritance could be claimed.

A very extraordinary case of successful concealment of sex is that of Dr. James Barry, who was Staff Assistant Surgeon in the British Army, and who died in 1865, at eighty years of age. This person was really a woman, as was proved by an autopsy. During this long period she had managed effectually to conceal her sex, although effeminate in appearance and without beard. She passed her medical examination and served in the army in different quarters of the globe, and exhibited all the usual qualities of a good soldier during her active life.

IMPOTENCE—STERILITY.

Impotence, or the want of procreative power in the male, may be functional or organic. The functional causes include debilitating diseases, masturbation, opium and alcohol habits. The organic causes comprise malformation of the genital organs, such as deficiency of the penis, fistula in perineo, castration of both testicles, cancer or other malignant disease of the testes, and malformation of the urethra, as hypospadias and epispadias. Some of these defects are remediable, while others are not. The mere absence of the testes from the scrotum does not produce

impotence, for such persons (crypsorchides) are capable of begetting children.

In professional language, the term impotence is applied to the male, while the term sterility usually refers to the same condition in the female, including both a physical sexual incapacity for intercourse and also unfruitfulness. A distinction, however, should be made. Strictly speaking, the male may be sterile without being impotent, as is seen in cases after castration and in some crypsorchides; or he may be impotent without being sterile, as when intercourse is prevented by physical malformation, although the testes may secrete healthy semen. Again, the female may be unfruitful without being incapable of intercourse, or *vice versa.* As regards the legal disqualification of the male on the ground of impotency, all that is necessary to prove is simply impotence or the incapacity for intercourse. In the female, incapacity for sexual intercourse (not sterility) can alone be adduced as a ground for divorce.

The procreative power in males usually commences at puberty with the full development of the sexual organs, especially the testes. The exact age of male puberty varies, but it may be stated to be from fourteen to seventeen years. Until this period is attained the semen does not contain spermatozoids, on which alone its fecundating power depends. Doubtless, certain cases of sterility are dependent on the absence of these from the seminal fluid. It would also appear that the power of impregnation is dependent on the activity of movement of these little bodies. The impotence of old age in the male is probably owing to the feeble motion of the spermatozoids, rather than to their deficiency.

The procreative power in the male may continue to very

advanced age, if conjoined with sound bodily health. Spermatozoids have been found in the semen at the age of eighty years, and even above. Certain diseases impair and destroy this power, such as disorders of the brain and spinal cord, dropsy, malignant fevers ; also blows on the head and spine.

Procreative power in the female.—The term sterility, when applied to the female, is usually understood to mean an inability to conceive. This power is manifested at puberty, or when the function of menstruation first appears. The precise age when this occurs differs in different countries and with individual females, the usual earliest periods being twelve and thirteen years (some exceptional cases as early as under one year and upward), and the latest periods nineteen to twenty-three years. Conception, however, may take place in women who have never menstruated ; and in a few exceptional instances the function never occurred throughout life, although the woman may have given birth to several healthy children and enjoyed good health herself.

Instances of premature puberty are not uncommon. Cases are reported where girls, one, two, or three years old, have exhibited the physical development of grown women, and in whom the catamenia appeared at this early age and the function was regularly performed. Menstruation ceases, in the majority of cases, at forty to fifty years of age, but there are many exceptions. As it may commence early, so it may terminate late—even up to sixty or seventy years, and in some remarkable instances even to eighty or ninety years.

The continuance of menstruation is usually indicative of the power of conception. Its termination nearly always

marks the cessation of the woman's ability to bear children.

It is undeniable that women have conceived after the cessation of the catamenia. The latest age for pregnancy cannot be absolutely fixed, although it is comparatively rare after forty-five years, and almost unknown after fifty-five years.

The causes of sterility in the female are various; some are organic, such as absence of the uterus or the ovaries, or disease of these organs; imperforate vagina or hymen; ovarian and uterine tumors; occlusion of the os uteri by constriction; malposition of the uterus, etc. Other causes are functional, as debility, excessive leucorrhea, dysmenorrhea, amenorrhea, menorrhagia, etc. It must also be remembered that women may be sterile with one man and fertile with another. It not infrequently happens that a woman who has been married for years without issue, in contracting a second marriage may have several children.

Legal Relations.—A suit for divorce may be procured by either party on the ground of impotency, provided it can be shown that the incapacity existed at and before marriage, and that it could not be remedied. There should be no delay in bringing the suit, and there should be proof that the incapacity was unknown to the complaining party at the time of the contract. If the alleged cause has supervened after the marriage, there can then be no grounds for a divorce. To sustain this charge of incapacity a medical examination is essential, but this must be voluntary on the part of either the man or woman; the courts cannot compel it. A mere unwillingness to submit to sexual intercourse on the part of a wife, or what the law terms a

"frigidity of constitution," would not justify a legal divorce There must be proof of sexual incapacity from physical defect in either party.

Certain cases of hysteria and of vaginismus, where intolerable pain, and even spasm, is produced in the woman at every attempt at intercourse, might possibly be regarded as affording legal grounds for a divorce. It was so determined in one case of hysteria in England; but as the other affection (vaginismus) is often remediable, it is doubtful if the courts would regard this as a sufficient cause for granting it.

CHAPTER XII.

RAPE.

Rape is legally defined to be the "carnal knowledge of a woman forcibly and against her will." A more correct and comprehensive definition would be "carnal knowledge without her conscious permission, or with such permission extorted by physical violence or fraud." Physical force, such as bodily injuries or partial strangulation, is not required by the law in order to constitute this crime; the employment of narcotics, anesthetics, or hypnotism, or the use of any fraud or pretence by which the will or understanding of the woman is influenced or overcome, is sufficient to bring the act within the limit of the law.

In ancient times this crime was variously punished by death, castration, fine, and imprisonment. At the present day, both in our own country and Great Britain, it is regarded as a felony, and is punished by imprisonment or penal servitude for a term of years. In England, until the present reign, death was the punishment for rape.

As this crime is usually committed in secret, and without witnesses, the law receives the evidence of a single person (the prosecutrix) as sufficient to establish the charge. As, however, false accusations are exceedingly common, medical evidence is generally required as corroborative proof. In former times the law required proofs both of penetration and emission on the part of the male; at present it is only requisite to adduce proof of vulval penetration, even without rupture of the hymen.

Rape on young children is more common than on adult women, and for this several reasons are assigned. The most obvious one is the comparative facility of the attempt, on account of the feebleness of resistance and the ignorance of children. Another reason alleged, particularly in Europe, is a superstition prevailing among the lower orders that an obstinate gonorrhea is most certainly cured by having intercourse with a virgin; and, therefore, a young child is selected for this purpose.

Most civilized states have fixed a limit of age, below which the act of intercourse is rape, even when permitted by the child. This is known as the "age of consent." It is not uniform in all countries; but in most of the United States a female under ten cannot consent to sexual intercourse. In cases of the idiotic, or feeble minded, or insane, the consent of the female is usually regarded as not excusing the criminality of the act; but each case must be decided according to the circumstances, such as the degree of mental imbecility, the proof of consent, and the employment of force on the part of the male.

In the case of an alleged rape, the duty of the physician summoned is, first of all, to make a note of the exact time and date of his examination, since this may hereafter serve an important purpose in determining if the prosecutrix took the earliest opportunity to complain. The time of the alleged offense should also be noted, as this may also involve the validity of an alibi. The female should be visited without giving her time for preparation, and the examination at once be made; but it should be remembered that this examination cannot be made without her full consent, and it is highly advisable that such consent should be given in presence of a witness. Examination of a female without her

consent constitutes an indecent assault for which the physician may be punished. It is probable that the courts would make no departure from this principle even if the examining physician were a woman. Medical evidence is derived (1) from marks of violence about the genital organs; (2) from bruises, wounds, or other marks of injury on the person of the woman, and also of the accused as denoting resistance on the part of the woman; (3) the presence of spermatic and blood stains on the person or clothing, or either, or both; (4) the existence of venereal disease on one or both.

Unless the examination be made very soon after the act, all traces of it may have disappeared. Three or four days may suffice for this; yet in many cases days or months elapse before an examination of the alleged victim is instituted, and mistakes consequently often result. Casper states that in fifty-eight cases he examined, the time that had elapsed from the alleged commission of the rape varied from three weeks to one year.

Rape on Children.—The fact of the greater frequency of rape upon children has already been stated. Out of 111 cases examined by Casper, the ages were as follows: seventy-eight from two and a half up to twelve years; seventeen from twelve to fourteen years; seven from fifteen to eighteen years; and seven from nineteen to twenty-five years. It is quite probable that nearly this proportion would be found to exist also in other countries. It should not be forgotten that many alleged cases of rape on young children are entirely fraudulent, trumped up (often by mothers) chiefly for extorting money. All the authorities mention numerous instances of this character. Casper states that out of thirteen cases examined he found nothing

whatever to support the accusation, although other physicians had pronounced them genuine, and some of them even exhibiting marks of chancre! In all genuine cases the genital organs should exhibit marks of injury, if the act has been completed, and especially if any resistance was made, such as laceration of the pudendum, the effusion of blood, and bruises of the neighboring parts. It is manifestly impossible, from the disproportion between the sexual organs, that a rape could be perpetrated by a man upon a young child without being attended with severe local injuries to the latter.

If the child be examined within two or three days after the act, the following signs will usually be found: inflammation and tumefaction of the vulva, with some abrasion of the mucous membrane; a muco-purulent discharge from the vagina, of a yellowish or greenish-yellow color and ropy consistence, staining and stiffening the girl's linen; painful urination, arising from the inflammation being extended to the urethra; clots of blood lying within the vulva and blood oozing from the abraded membrane. The hymen may be found either destroyed or lacerated, or very possibly not injured at all. In relation to the condition of the hymen in very young children, it should be remembered that in them it presents a variety of conformation, sometimes being very far back in the vulva, so as to render it difficult to find; in such cases it may entirely escape laceration. In fifty-four cases of actual rape upon children, many of them under fourteen years of age, and complicated with syphilis, Casper found the hymen uninjured in four-fifths of the number.

Unnatural dilatation of the vagina may be mentioned as a frequent sequence of rape on young children; but this con-

dition may be produced by the passage of hard bodies in order to substantiate a false charge. Casper once examined a girl only ten years old whose mother had gradually dilated her vagina with her fingers in order to fit her for sexual intercourse.

In making an examination, in the case of an alleged rape on a child, several points are to be considered. In the first place, it should be recollected that for the legal establishment of the crime, both in children and adults, it is only necessary that vulval penetration, however slight, be proven. It is not required that the hymen should be destroyed. It has been so decided repeatedly. If after an early examination no marks of violence about the sexual organs or other portions of the person are discovered, this would a strong presumption against the validity of the charge. On the other hand, the mere presence of marks of violence about the pudendum is not of itself sufficient to prove a rape, since these are sometimes inflicted purposely upon young children by designing mothers in order to make out a false charge against an innocent man. Further, the absence of the hymen is not of itself a proof of rape, since this membrane may have been previously destroyed by suppurative inflammation, or by ulceration, also by accident, or even designedly, in order to substantiate a false charge.

The question whether venereal disease could be communicated to young children otherwise than by sexual contact must be answered affirmatively, as by the use of sponges or cloths which have been previously employed by adults affected with these disorders. Such instances, however, are rare ; but they might be accepted as probable where no signs of violence or soreness of the parts existed. The muco-purulent discharge which invariably follows upon

the defloration of a young girl should not be confounded either with gonorrhea or with infantile leucorrhea. The latter disorder is of spontaneous origin, and is very common among children of the lowest orders whose hygienic surroundings are bad. The existence of this discharge is not infrequently made the ground of complaint against an innocent man for a felonious assault upon the person of the young girl, who has been previously tutored to tell her story, even to its minutest details. In cases of this kind it is always best to examine the child apart from all her associates, but in the presence of a competent third party if possible.

Gangrenous inflammation of the vulva is more rare than infantile leucorrhea ; it sometimes prevails epidemically, and occurs as a sequel to low fevers and other prostrating diseases ; it is found almost exclusively among neglected, filthy children, suffering from exhaustion and want of food. The mortification in these cases frequently terminates fatally.

To diagnosticate properly between these spontaneous infantile diseases and gonorrhea or a muco-purulent discharge, the examiner should remember that a true gonorrheal discharge does not come on until about the fourth to the eighth day, and is usually very profuse—much more so than that which results simply from the violence of defloration ; also, that its duration is much longer. Casper recommends that in doubtful cases a second examination should be made in the course of a week or ten days. If the purulent discharge has then ceased, or is about ceasing, there is good reason to believe that it was not due to gonorrhea. Again, if the muco-purulent flow is of spontaneous origin (leucorrhea), there will be an absence of blood ; whereas, if it be due to violence (rape), there will

always be more or less effusion of blood, along with dilatation, and probably laceration of the vagina and rupture of the perineum. The discovery of the specific microbe will aid materially in this examination. In all such cases the person of the accused should be examined for evidences of gonorrhea, and also for blood stains upon his person or clothes; but the absence of the latter would be no proof that he had not committed the crime, since the bleeding of the pudendum may not have taken place until after the act. Several cases of this character have been reported. Moreover, the discovery of seminal stains upon either the accused or the victim might be regarded as positive proof of guilt, unless it could be shown that a previous and recent defloration has occurred.

Rape on young children has not infrequently resulted in death; the violent laceration of the vagina and perineum producing, in some instances, mortification, and in others fatal peritonitis.

Rape on Adult Females.—The question is frequently raised as to the possibility of a rape being committed by one man upon a healthy, vigorous, adult woman. A determined and vigorous resistance may prevent the perpetration of the crime. On the other hand, the woman may be forced to yield through fear of her life, or duress, or may be actually overpowered through superior strength, or fraudulently deceived by the administration of narcotics or anesthetics. Casper gives an instance where a healthy woman, twenty-five years old, was violated by a single man. Every case of this character must be judged on its own merits. The physician has simply to state, from an examination of the parties, that sexual intercourse has taken place, leaving

the jury to decide whether or not rape has been perpetrated. Doubtless, in some of the many false accusations of rape, Sancho Panza's mode of sifting the evidence and his subsequent judgment in the case, during his brief though brilliant experience as Governor of Barataria, might be held up as a safe guide to follow. In some cases there are accomplices to the crime, when, of course, there can be no hesitation as to the possibility of overcoming the resistance of the victim by mere brute force.

It must also be admitted that rape may be perpetrated on adult women when rendered unconscious by means of powerful narcotics or anesthetics, or when thrown into the mesmeric condition, or when in syncope or the coma of apoplexy; but whether the act can be accomplished when the female is merely in a profound natural sleep, and unconsciously to herself, is a question which admits of considerable discussion. The cases of this character are certainly exceptional; but their possibility must be admitted—certainly in the case of women accustomed to sexual intercourse, but very doubtful in the case of virgins; although we may not deny the possibility even in the latter, inasmuch as authentic instances are mentioned by reliable authors. There will always necessarily be more or less doubt in the matter, and the oft-quoted dictum of Valentin deserves consideration: "*non omnes dormiunt quæ clausos habent oculos*."

A question of much importance is whether the anesthetic effects of ether or chloroform are capable of so completely abolishing consciousness and sensibility on the part of a woman, especially a virgin, as to permit the successful perpetration of a rape. A somewhat remarkable case involving this question was tried in Philadelphia in 1854. The

plaintiff was a young lady of unimpeachable character, who charged a very respectable dentist with committing a rape upon her while in his office and under the anesthetic influence of ether for the purpose of an operation upon her teeth. She averred very positively in her testimony that she was conscious of his "entering her person," and then "felt pain," but she "was not able to cry out or resist," and "all this time was conscious of everything that was going on." She afterward "opened her eyes," and again "closed them immediately." After this alleged liberty she states that she inhaled the ether a second time, at the doctor's request, in order to have a tooth extracted. When this was over she made a second appointment with him for some days after. She parted with the dentist at his front door without making any complaint, leaving a kindly message for a mutual acquaintance. From his office she walked a considerable distance to a friend's house, stopping on the way at a confectioner's to partake of ice cream. After her visit to her friend she again walked quite a distance to another friend's house, where she remained several hours, and after tea on that same evening first informed any one of the alleged outrage; and on the same afternoon her catamenia appeared, which was her regular time. She further stated that "she did not examine her person before the appearance of the menses, nor did anybody examine her garments before two days had elapsed. She was never examined by any physician." Her complaint was lodged before the authorities, and the defendant was arrested, tried, convicted, and imprisoned for a term of years.

The general opinion of the medical and legal professions, both at the time of this trial and since, was that this conviction was unjust, and unwarranted by the circumstances of

the case. The most serious defect in the evidence was the total absence of any medical examination to prove the recent defloration of the plaintiff. It really appears to us unaccountable how such a grave charge could have been for a moment entertained by the court and jury against a man of unsullied character in the absence of this most important link in the chain of evidence. We must suppose it to have been one of those instances mentioned by Sir Matthew Hale, "wherein the court and jury may, with so much ease, be imposed upon without great care and vigilance, the heinousness of the offense many times transporting the judge and jury with so much indignation that they are over-hastily carried on to the conviction of the persons accused thereof, by the confident testimony of sometimes false and malicious witnesses." The defendant in this case is still living (1897) and in reputable professional standing.

The important point in the above and similar cases is whether an individual under the influence of anesthesia has such complete control over the mental faculties as to fully recognize and appreciate what is transpiring around her, and afterward to minutely describe all the particulars, and yet, at the same time, lose the power of resistance? Such an abolition of the will as to destroy all power of resistance implies a narcotism so complete as to produce complete unconsciousness. Nothing is more certain than that in such a person the sense of external impressions becomes at first very confused, and very soon is entirely obliterated. The most painful operations seem to produce no sensation whatever. As to the perceptions, they soon become perverted; the person passes rapidly into dream-land, "the inward perceptions of the mind being sometimes of the most agreeable, and at others of the most painful

character; and these dreams may or may not be pertinent to the actual position of the patient."

But it is especially upon the emotions that the effects of etherization are most conspicuous; some exhibit signs of irrepressible mirth, while others appear weighed down by despondency or excited to violent anger. Women are especially liable to be thus affected, and in some the erotic feelings are unquestionably excited to a high degree. We have frequently witnessed this ourselves in female patients, and the fact is abundantly corroborated by others. The case just alluded to was of a character precisely suited to illustrate this point. The young lady was betrothed in marriage; she was accompanied by her lover in her walk to the dentist's; she was just at her menstrual period. What more natural, under such circumstances, and when her senses were "stolen away" by the anesthetic, than that her dreams or false perceptions should take the direction which should give rise to erotic emotions and sensations? That this is not mere speculation is shown by well-attested facts. M. Dubois relates a case under his own observation where a woman undergoing an operation, under the influence of ether, drew an attendant toward her to kiss him as she was lapsing into insensibility; and she afterward confessed to dreaming of coitus with her husband while she lay etherized. Another case closely resembling the one now under consideration occurred in Montreal in 1858. A dentist was indicted for attempting to commit a rape upon one of his patients under the influence of chloroform. At the trial a witness testified that his wife was under the strongest impressions that she had been violated while under the influence of chloroform; yet the husband had been present during the whole time.

In such cases, therefore, extreme caution should be exercised in receiving the testimony of a prosecutrix who was under anesthetic influence, unless her statement is corroborated by a proper medical examination.

Medical Evidences of Rape on Adults.—In the majority of these cases the examination is postponed so long as to afford very few satisfactory data to the physician, since all traces of violence in adults may disappear in a few days. If much resistance has been offered there will generally be found bruises upon the thighs and legs, and possibly upon the arms and trunk, and even on the neck, when an attempt at partial strangulation has been made; but these are inconclusive of rape without the presence of marks of violence upon the pudendum. Besides, they may be produced by the woman herself, in order to substantiate a false accusation. In children, for obvious reasons, these marks of violence do not occur. The truly important medical signs are derived from the condition of the hymen and of the sexual organs, and from the presence of seminal and blood stains. It should be remembered that these physical marks of rape about the genital organs may be found whether the connection has been voluntary or involuntary. Thus, rupture of the hymen, laceration of the vagina, swelling and soreness of the organs, effusion and coagula of blood, stains of semen and blood upon the person and clothing, may be met with in both cases.

Another circumstance to be recollected is that girls and young women are liable to a muco-purulent discharge arising from vaginitis, somewhat similar to that already noticed as found in young children under bad hygienic conditions. Older women are liable to leucorrhea, which may some-

times be accompanied with an ulcerated state of the vagina and general soreness and swelling of the parts. It is possible that a woman thus affected might bring a false charge of rape against an innocent man, alleging that her present condition was the result of a rape. Although an ordinary leucorrhea can readily be distinguished from a gonorrhea,—the discharge of the latter being purulent, while it is mucous in the former,—yet a purulent discharge may take place from the vagina, as the result of an intense vaginitis, quite independently of sexual intercourse; and such a discharge cannot readily be distinguished from that of gonorrhea. Taylor very properly remarks that "such discharges, commencing before but continuing and sometimes becoming aggravated after marriage, have given rise to unfounded suspicions of infection from venereal disease imparted by the husband, and have thus led to suits for divorce."

Condition of the Hymen—Virginity.—Much has been said about the unruptured condition of the hymen being accepted as a proof of chastity or of virginity, and unquestionably in the great majority of cases this is true; but it cannot be affirmed absolutely and without exception, inasmuch as authentic instances are recorded where the hymen has been destroyed, either by accident, disease, self-abuse, or by a surgical operation to allow the escape of the menses; and, on the other hand, where sexual intercourse has been continued for years with the hymen unruptured, and where even pregnancy had resulted, and it became necessary to divide the membrane with a knife before delivery could be accomplished.

In the exceptional cases just alluded to, of the persistence of the hymen after repeated intercourse, this anomaly may be ascribed, according to high authorities, to an abnor-

mally firm, hard, and resisting structure of the membrane, due to the presence of a fibrous or fibro-elastic tissue. It therefore must follow, from all the above facts, that the loss of the hymen is not an infallible proof of a loss of chastity; nor does the existence of a hymen constitute an absolute evidence of its presence. Casper, however, considers "that where a physician finds a hymen still preserved, even its edges not being torn, and along with it (in young persons) a virgin condition of the breasts and external genitals, he is then justified in giving a positive opinion as to the existence of virginity, and *vice versa*."

The other external evidences connected with the sexual organs, such as swelling and soreness of the vulva, the presence of effused blood and of seminal stains, would all afford strong corroborative proof of rape, provided want of consent could be satisfactorily shown and an early examination be made.

Blood and Seminal Stains.—These may be found upon the persons and clothing of both the ravisher and his victim. If the garments are tolerably clean, there should be no difficulty in recognizing these spots; but they are frequently presented for examination in such a filthy condition as to render their identification very difficult. Moreover, a mistake may arise from the woman's garments being intentionally soiled with blood, in cases of false accusation.

The manner of examining blood stains has already been explained.

Examination of Seminal Spots.—These stains cause a stiffening of the fabric, like those produced by albumin or gum. The seminal stain may be identified as follows: If gently warmed, it will assume a pale yellow color. If

moistened with warm water, it will emit the seminal odor. Cut out the suspected stain and place it in a watch glass, adding a few drops of pure water and gently squeezing it with a glass rod until thoroughly soaked ; remove the fragment and add a drop of nitric acid on a glass rod, when the liquid, if seminal, will turn a yellow color, without giving a precipitate. The best results will be obtained by placing a small fragment of the stained material on an ordinary microscopic slide, moistening it with a drop of distilled water, and placing over it a cover-glass. After soaking for a short time (30 to 60 min.) the cover-glass is rocked by pressing on alternate sides, thus causing a current of water to flow through the fabric, from which the spermatozoids will gradually float out. Several slides should be prepared from each stain. If very good results follow the application, the cover-glass and fabric may be removed and the slide dried and preserved ; under ordinary circumstances such results are not attainable. If the water used in the test be slightly tinted by eosin or methyl blue, the spermatozoids will take up the dye, and may be more easily detected. Cut out a fragment containing the stain and treat it with distilled water as above described. After sufficient soaking, apply a drop of the liquid to a glass slide and place it under the microscope, using a very high power.

The spermatozoids have a characteristic appearance. They vary considerably both in numbers and size. On an average, the human spermatozoid is about the $\frac{1}{600}$ of an inch in length, having a flattened, ovoid head, which is about one-third the diameter of a human blood corpuscle. Attached to this head is a thread-like, tapering tail, that is eight to ten times longer than the head. Very often, in

old seminal stains the spermatozoids will be found only in a fragmentary state, and the examiner should be cautioned not to confound these with fibrilla and other bodies which might be accidentally present. The absence of spermatozoids is not to be regarded as conclusive that the spot is not seminal, since, as Casper and others have shown, the seminal fluid does not always contain them; they may be absent in certain debilitating diseases, after excessive venery, and in very aged men.

These bodies exist in the semen of all animals capable of procreation, and they are found in man from the age of puberty to a very advanced period of life.

It is possible to mistake fragments of the spermatozoids for fibrils of linen and other fabrics washed out at the time of the examination. A proper degree of caution, together with a knowledge of the peculiar microscopic appearance of these fibrils, should prevent this mistake. Hence, in such an investigation it is safest not to decide upon the seminal character of the stain unless one or more complete spermatozoids are found.

M. Donné has described an organism called by him *Trichomonas vaginæ*. It is found in vaginal mucus, and resembles the spermatozoids, but differs in having the head three times as large; it is also granular, and armed with a row of four or six cilia.

The spermatozoids appear to retain life long after the death of the body. Hoffmann observed active movements in them from eighty to one hundred hours after death. In the dried state they may be identified years afterward.

In some cases of alleged rape it may be necessary to examine the vaginal secretion for evidence of recent intercourse. If this has occurred, the presence of the sper-

matozoa may easily be discovered by placing a drop of the mucus upon a glass slide and subjecting it to microscopic examination. It has been shown by Müller that the spermatozoids will retain life and activity for eight days in the vaginal mucus.

Posner has recently published some experiments on the test for seminal fluid called the Florence reaction. A strong solution of iodin in potassium iodid and water added to fresh semen produces numerous dark-brown crystals of various forms. The reaction does not depend on the presence of spermatozoids. Extract from the ovary also gives these crystals. The reaction is not peculiar to semen.

Evidence of Rape on the Dead.—The physician is sometimes required to determine the fact of violation previous to death when a murder has been committed. The difficulty here is, of course, increased by the absence of evidence from the woman. The proofs of violation in the case of a very young girl would be easily made out; but in the case of an adult, even if the evidence of rupture of the hymen and vulval swelling and effused blood pointed to a recent defloration, this would not prove the want of consent on her part. If, however, there existed at the same time other marks of extreme violence upon the body, this would be strong circumstantial evidence that the outrage had been perpetrated before the murder.

Cases of sexual intercourse with the dead body have occurred at all periods of human history. Of late years several cases have been detected among morgue keepers. Obviously, there will be difficulty and uncertainty in fastening the offense on any one, unless, as has occasionally happened, the person is caught in the act.

Rape of Females on Males.—This crime is rarely brought before the courts, but seems to be more common than has generally been supposed. Boys are occasionally induced or forced into sexual intercourse with adult women to gratify the erotic feelings of the latter without the danger of pregnancy. A boy seven years old, with well-marked gonorrhea, presented himself for treatment at the clinic of the Jefferson Medical College Hospital. He stated that he had contracted the disease by gratifying the erotic desires of a married woman whose husband was at sea.

Unnatural Crimes.—*Sodomy—Pederastia; Bestiality.*—Sodomy, or Pederastia, is the unnatural intercourse of man with man. Bestiality implies unnatural intercourse with animals. Both acts are criminal, and are regarded by the law as felonious, and are punished in England by penal servitude and in this country by imprisonment for a term of years.

In the case of sodomy, both the parties are held to be equally guilty, unless it can be shown that one was not consenting, was under age, was unconscious at the time, or was idiotic or insane. The facts of this crime are usually proved without medical evidence, except in the case of young persons, when marks of physical violence will usually be sufficiently apparent. Collateral proof would be given by the discovery of seminal stains upon the person or linen.

Unless the examination be made soon after the perpetration of the act, all evidence of it will have disappeared, just as in cases of rape. In those habituated to this vice, there are, according to Casper and Tardieu, certain alterations of the parts that may be regarded as characteristic, such as a

funnel-shaped condition of the anus, which is enlarged, smooth, and even patulous, the folds, or rugæ, having disappeared. There may also be other marks around the anus, such as cicatrices, chancres, and venereal warts. In recent cases, laceration of the sphincter ani, fissures, and bruises, with effusion of blood, might all be observed.

Legal Relations of Rape.—The crime is not excused if the woman has submitted—

(1) From stupefaction, produced either by disease (coma) or by drugs—including alcohol, chloroform, and ether—or by hypnotism. Although, in such cases, the violation, strictly speaking, be not against her will, it is without her will, which is regarded as the same thing. This is true, even if it can be shown that the drug was administered for the purpose merely of exciting, and not stupefying. It is vastly important that the distinction should be clearly drawn between the erotic sensations and perverted impressions of a female while under an anesthetic influence for surgical operations, and who may subsequently institute a false accusation, and similar sensations resulting from the criminal administration of chloroform or ether for this very intent, and where the will or resisting power appears to be taken away before the anesthesia is complete.

(2) From Ignorance of the Nature of the Act.—Such instances occur in young children, and in older women who are idiotic or insane. In some recent cases, both in this country and in England, it has been held that, in dementia not amounting to positive idiocy, if consent were given, and no compulsory force employed, it does not constitute rape.

(3) From Mistake of Person.—More than one case has been reported in which a married woman was raped in her sleep, supposing she was embraced by her husband.

(4) From Fear.—Submission extorted through fear of death or violent threatening is no excuse for the act.

(5) From Prior Want of Character of the Prosecutrix.—Prior want of character in the woman is no ground of excuse for the crime, if it was perpetrated by force and against her will; not even if she were a common prostitute or the mistress of the defendant. The allegation of unchastity in the woman could further be supported by a medical examination, which might reveal the existence of syphilis or gonorrhea. This examination is not compulsory; the woman is not obliged to convict herself.

(6) Subsequent Suppression of the Fact by the Prosecutrix.—If the alleged violation be suppressed by the woman for such a time as to prevent any evidence being obtained by a medical examination, this will go very far in lessening the credibility of her testimony. Not a few instances of this character have turned out to be cases of false accusation.

(7) Want of Age and of Sexual Capacity of the Defendant.—According to the law, a child under a certain age is presumed to be incapable of committing a rape, though he may be convicted of an assault with intent to ravish. The want of sexual capacity is purely a medical question to be determined at the time.

CHAPTER XIII.

INSANITY.

In a work like the present, it would be impossible to enter into an extended discussion of the subject of **Insanity.** Reference must be made to the many admirable treatises now accessible, both in English and foreign languages. All that can be accomplished is to present the subject under certain particular phases, with a special reference to its medico-legal relations, so as to enable the student to understand the proper professional position in reference to that class of persons who have been deprived of reason—how to determine, first of all, the *fact* of their insanity, and, secondly, its *degree*, as involving the all-important question of their civil and criminal responsibility.

The physician may encounter considerable difficulties in cases of real or alleged insanity. In the first place, there is the difficulty, if not the actual impossibility, of determining the precise boundary between normal and abnormal mental action, just as it is often impossible to do in the case of bodily health and bodily disease. Even in respect to the individual mental powers or faculties, the greatest variation is observed. Rarely do we find in society a specimen of a perfectly normal and harmonious adjustment of all the powers of the mind. Scarcely ever is a person discovered in whom no one of the mental faculties is allowed to exert an undue preponderance. "On the one hand, for instance, individuals are observed who possess, along with a wondrous power of memory, just as feeble a power of judgment;

while others, to the most vivid powers of imagination conjoin a most wretchedly deficient power of will. In one, an excessive vivacity of character may betray its possessor into actions which may raise doubts as to his actual sanity; whilst in another, originality of character, flashing out as true genius, may so stamp its peculiarities on every act as to require a sharp observation if the limits of sanity have not been over-stepped." (Casper.)

Another great difficulty in deciding this matter arises from the impossibility, often, of discovering the motives of any action, even the most extraordinary. Whilst the absence of all rational motive may usually be regarded as indicative of an insane act, we must not be too ready to admit this absence in any particular case, since these motives, as Casper justly remarks, "may be so deeply buried in the soul of the agent as frequently to baffle the greatest experience in arriving at a logical conclusion." The subject of motive in the acts of the insane will be noticed further on.

Still another difficulty in the diagnosis of an alleged mental disorder is presented by the possibility, on the one hand, of its being feigned, and, on the other, of the real disease being concealed by the subject with the most consummate art.

All the medico-legal questions arising out of insanity are comprehended under the twofold inquiry: first, as to the civil responsibility of the individual, and, secondly, as to his criminal responsibility. These two points cover the whole ground of a medico-legal investigation in every case of real or unsuspected insanity.

Civil responsibility means the capability of managing the ordinary affairs of civil life, such as the entering into contracts, the making of a will, the performing the functions of

a public officer, or, in common-law phrase, "the managing his own affairs."

Criminal responsibility has reference solely to criminal acts, and involves the inquiry whether an individual committing some particular crime, such as murder, theft, or arson, was in such a state of mind at the time of the commission of the deed as to constitute him a responsible agent?

One other point is to be noted: every human being of responsible age and sound mind is conscious of possessing the power of will, or of moral freedom—of choosing between good and evil; and although, in consequence of faulty training, bad associations, and the power of temptation, he may "choose the evil," yet he is fully responsible for this choice and all its consequences, provided he possessed, at the time, a sound mind.

Legal Terms.—Before further entering upon a discussion of the subject, it will be proper to define certain legal terms. A medical witness should confine his answers strictly to the questions put to him, and speak of insanity only as a disease, avoiding the tendency to theorize, or speculate upon legal distinctions.

An illusion is a false mental impression derived through the senses. Real things are distorted. A timid person, for instance, may mistake, in the dark, a post or a shrub for a man; or the drapery of his bed curtains, in the moonlight, may be distorted into an apprehended ghost. Sometimes the false impression is entirely mental, reproduced by the memory, or by a strong effort of the will, recalling the scenes of past pleasures or sorrows, the features and persons of friends, and even the tones of their voices and other sounds. Such mental images, denominated by Rush wak-

ing dreams, are called spectral illusions, or phantasms, when they have reference to the sense of sight, although the actual vision of the individual may, at the time, be defective, since they occur equally to the blind.

The distinctive characteristic of an illusion is that the false perception can be soon corrected by an appeal to the other senses or to the judgment. If, however, it is persistently believed to have a positive existence, and this belief is not removed either by reflection or by a reference to the other senses, then the illusion becomes a delusion, or a misleading of the mind, and it indicates a disordered mind.

A hallucination is also a perverted perception, but without material basis. The false impressions are often conveyed through the organs of hearing. If the individual is able to correct them by his judgment, or by reference to his other senses, they are of no significance; but if they are firmly believed in, they indicate a deranged mental condition. If the person fancies he hears strange voices, constantly urging him on to the commission of some horrible crime, or sees purely imaginary personages, these are among the surest indications of insanity.

Some writers make no distinction between hallucinations and illusions, whilst others, and we think very properly, regard them as differing in this: a hallucination is an unreal sensation wholly due to the action of the brain; an illusion is a real sensation—that is, is produced by some real object, although distorted. Nicolai, the Berlin bookseller, was for years troubled with seeing unreal objects (spectral illusions), and sometimes by hearing unreal sounds (hallucinations), but he did not believe in them; hence they never became delusions in his case.

A *delusion* is a belief in something purely imaginary,

and which has no real existence, and in which this belief cannot be corrected by the judgment, nor when confronted with contradictory proof, as, *e. g.*, when a man imagines himself made of glass, and is afraid to suffer any one to approach him, lest he be broken to pieces ; or where a pauper fancies himself to have suddenly become a millionaire or a king ; or where a rich man imagines himself to have been reduced to beggary, etc. All such delusions are clear manifestations of mental disturbance. In legal matters, however, the question of responsibility (whether civil or criminal) depends upon the connection of the act with the particular delusion. For example, if the delusion is such as to prevent the individual from exerting a "rational act of volition" in the matter of disposing of his property by will—as when, through such delusion, the result of disease, he may have come to entertain a bitter hatred for those entitled to his love and gratitude—then he does not possess testamentary capacity, and is, so far, of unsound mind. But if the delusion be upon a subject entirely disconnected with the act, as where, for example, it has reference to his religious state, then the responsibility of the individual is not necessarily destroyed, and his testamentary capacity should be regarded as unaffected.

The existence of the most extraordinary delusions for years, in an individual, is quite consistent with an otherwise apparently sound mental condition. Dr. Reese was acquainted with a highly-educated lady, an artist of considerable abilities, who entertained the delusion that she was, in some mysterious manner, incorporated with the Holy Trinity, and that she received direct communications from the Father, which required her to give up all her church relations and her former very strict orthodox creed. Yet

this lady went out into society, conversed intelligently upon ordinary subjects, and passed generally for a sensible woman.

The cunning of the insane in concealing their delusions is often quite remarkable. Every superintendent of an asylum has had experience of it in patients under his observation. Perhaps the best illustrations are afforded in cases in which patients, who wish to escape from an asylum, are brought into court, under writ of *habeas corpus*, for their discharge, and where they so skillfully and adroitly pass their examination as often to deceive both court and jury.

An oft-quoted instance of the above will bear repetition here. The late Lord Erskine was engaged in a case in which a lunatic had brought an action against his brother and the keeper of the asylum for false imprisonment. The man was closely interrogated by the learned lord for nearly the whole day, without his being able to elicit anything to prove his delusions, when a gentleman came into court and suggested to the learned counsel that the patient believed himself to be Jesus Christ. Lord Erskine immediately acted upon the hint, and addressed the man with a profound reverence, suitable to his assumed character, and apologizing for his former want of respect. The patient at once expressed his forgiveness, and, with the utmost gravity, in the face of the whole court, said, "Yes, I am the Christ."

The following description is copied from J. Dixon Mann's work on Forensic Medicine and Toxicology. It is inserted because it is a vivid and typical picture of the course of a case of simple insanity:

"Insanity does not develop in a moment; there is a period of ingravescence during which the individual affected gradually deviates from his ordinary mental condition. Although

the symptoms evinced during the various stages of insanity are irregular and do not follow any definite order, certain of them are of common occurrence, some of which are present in every case; a knowledge of these symptoms is essential to an early recognition of mental disease. The onset of insanity may be so insidious that long before any distinctive indications are manifest an alteration in temperament is noticeable; the individual is different from what he was formerly; he has lost his equanimity. When insanity begins in this insidious way the emotions are affected long before the mind is impaired. The patient is subject to unaccountable waves of depression, which may alternate with periods of excitement; he becomes unwontedly irritable and is unable to control his temper under the petty annoyances of every-day life. This instability of temper may be the condition that first rouses suspicion in the minds of his friends that insanity is the cause of the change in disposition. A man who has been moody and reserved in his manner for some time is credited with being overtaxed with business, and is thought to be a little out of sorts, but nothing more; at some trifling contradiction or annoyance he suddenly blazes up into a frenzy of passion, and behaves for the moment so like a madman that the bystanders are at once impressed with the idea that the balance of his mind is impaired. A change in the emotions is also commonly shown by transformation of like into dislike, or love into hate. A man shows unwonted impatience at the remarks addressed to him by his wife, whose opinion he previously valued, and then manifests an absolute antipathy to her, a sentiment totally at variance with their former relations. Loss of interest in objects and pursuits which formerly occupied his attention, desire for solitude perhaps

at first shown by avoidance of social intercourse in a general way, and then, in a more special manner, by seclusion from the family circle, are further evidences of perverted sentiments. At this period, the person affected is often quite capable of brightening up in the presence of strangers, or of friends for whom he has a special liking ; he will even remark that he feels better in company—meaning in the society of those with whom he is not necessarily brought into relation.

"So far the intellect is unimpaired. The capacity to fulfill the duties which devolve upon a merchant or professional man may be equal to the requirements ; but the work is done in a perfunctory way without the display of any interest. The morbid state of the emotions, however, soon reacts on the mind in such a way that the reasoning processes are interfered with, and the judgment is no longer that of a sane person : emotional depression gives place to morbid apprehensions, and an indefinite feeling of melancholy to dread of impending ruin in this world or in the future state. Delusions occur at this stage. Among the commoner delusions in the early stages of insanity is the conviction that some one—generally a member of the patient's family—has commissioned the police or a private individual to act as a spy on the person laboring under the delusion ; that there is a conspiracy to ruin him, or to deprive him of his rights ; that attempts are being made to poison him. The last-named delusion frequently causes those who are afflicted with it to arm themselves with a number of bottles of medicine or parcels of food, and to seek the advice of a chemist, requesting him to analyze the samples for various poisons. It is rather curious that suspicion is not always directed against those who might be reasonably

suspected of criminal motives,—such as the members of the family who would be benefited by the death of the deluded person,—but druggists and other shop-keepers who are almost strangers to him are often the alleged secret assassins; sometimes the allegation of conspiring is made to account for this inconsistency."

Lucid Interval.—In a legal sense, this term means a temporary intermission of the insanity, during which the reasoning power is recovered. It differs from a mere remission of the symptoms, such as is seen in some cases of violent mania. During such an interval, the law recognizes the power of the individual to make a will, to sign a contract, or exercise his civil rights. He is also held responsible for crimes committed during such a period. The duration of these intervals is uncertain, varying from a few minutes to weeks or months. If the interval is very short, the fact of its alleged existence is always the more questionable.

Lucid intervals are most common in mania; they also occasionally occur in dementia, when not chronic. They are never met with in idiocy and imbecility.

In order to establish the fact of the existence of a lucid interval, the burden of proof rests upon the plaintiff in a suit in which he desires to prove the validity of a contract made by the lunatic during such interval.

Varieties and Classification of Insanity.—Much difference exists among the authorities in this respect; the following will serve the purpose of the work probably as well as any system:

1. Idiocy.
2. Imbecility.
3. Mania.
4. Melancholia.
5. Monomania.
6. General Paralysis of Insane.
7. Dementia.
8. Certain forms of mania having distinct etiological relations.

Idiocy is distinguished from all other forms of mental disorder by being congenital; and this condition is manifested by imperfect development of both body and mind. The idiot, from an original defective structure of the brain, is able to acquire only a limited degree of intellectual power. His instincts, habits, and appetites are largely animal. Often there is no sign of recognition, nor indication of memory, in which respect he is below many animals. There are some cases of idiocy, however, in which the want of cerebral development is not so great, and some intelligence is manifested, with a partial development of some few of the faculties. Such idiots are docile and tractable; they are capable of being taught many things by careful and judicious training, even to talk and read; and thus of being materially improved.

Among the causes of idiocy are intemperance in the parents, and marriages of consanguinity. Syphilis has also been supposed to predispose to idiocy in the offspring. Idiots are generally short-lived, their age rarely extending beyond thirty years.

Physical Peculiarities of Idiots.—These are manifested in smallness of the head, in the majority; thickness of the

lips, which are often fissured, particularly the lower one; enlargement of the tongue, salivary glands, and tonsils; vaulting of the hard palate; irregularity of the teeth, with tendency to early decay; deficiency of the lobules of the ears; defects of vision, such as myopia and congenital cataract; weakness and clubbed appearance of the fingers and thumbs, and want of power over the sphincters. In some idiots the head is preternaturally large, especially in congenital hydrocephalus.

An autopsy will generally disclose a deficiency of gray matter (from a defective size of the brain) and a want of proper development of the convolutions; sometimes an absence of the entire cerebellum, of the pineal gland, of part of the fornix, of the olivary bodies, thalamus, and corpus striatum; and an absence, or rudimentary state, of the corpus callosum and soft commissures. Deaf-dumbness is common. Some are born deaf, dumb, and blind; yet, in the case of Laura Bridgman, the deprivation of all these faculties did not prevent acquiring a remarkable degree of intelligence, under careful training.

While the higher faculties are wanting, there often exists a marked development of the lower ones, such as the love of money, sexual feelings, gluttony, and filthy habits, together with a slow and tottering gait.

Cretinism.—A peculiar form of idiocy, at one time supposed to be endemic in certain mountainous countries, as Switzerland, Savoy, etc. It is chiefly marked by an enormous development of the thyroid gland, which, however, in some cases, may be altogether absent. The mouth is large, and the hands and fingers misshapen. The eyes are squinting, the face pale and sallow, and the speech thick and

muffled. The intelligence is about that of idiocy. The smaller goitres found in other countries do not necessarily impair the intellect.

Imbecility.—This differs from idiocy chiefly from the fact of its being acquired after birth ; the bodily defects are also asymmetrical, and the intellectual manifestations are rather different, being exhibited in low, mischievous cunning, bad temper, silliness, and stupidity, and may often be accompanied with epilepsy or paralysis (Hamilton). The power of speech is less frequently absent than in idiocy.

The precise boundary between idiocy and imbecility cannot be defined, so far as intellectual manifestations are concerned, unless we make the distinction to consist in the congenital character of the former. Neither of them is likely to be confounded with mania and monomania, since in the former there is a total absence of ideas and of the power of thought, both of which are present in maniacs and monomaniacs, although perverted and irregular. Moreover, idiocy and imbecility are destitute of hallucinations, which are characteristic of mania and monomania. Their resemblance to confirmed dementia is much stronger.

Legal Relations of Idiocy and Imbecility.—When these mental conditions are positive and distinct, there can be no question of their entire irresponsibility, both civil and criminal.

Mania.—This variety of mental disorder is characterized by a general perversion of the mental faculties, accompanied by more or less excitement, sometimes amounting to fury. The reasoning faculty is not absolutely lost, but disturbed and confused ; ideas flow through the mind without order or connection ; they are evolved from the brain in chaotic

exuberance, following one another with inconceivable rapidity and entirely without control. With the maniac everything is active—the emotions, the memory, the imagination, the speech, and the features. "He mingles abusive, obscene, and blasphemous words with the most pious reflections." His movements are brusque, disorderly, and extravagant; he dances, runs, leaps, tears off his clothes, breaks things, and exhibits enormous strength. The voice becomes hoarse, the skin is dry and hot; the eye has a peculiar, wild, brilliant expression, with often a fixed stare. The pulse is rapid, and respiration and temperature above normal. They generally eat enormously and voraciously. Urine and feces are often passed involuntarily; the bowels are apt to be torpid; perspiration abundant and sour. There is frequently sexual excitement, particularly in females, and when this is the chief feature of the mental disturbance, it is called satyriasis in males, and nymphomania in females.

Along with the intellectual, the moral faculties become more or less perverted, and the patient's social and domestic relations are greatly altered, jealousy, suspicion, and hatred being evinced toward those whom he had formerly loved with the deepest affection. He is haunted by the wildest delusions, under whose influence he may act in the most dangerous and ungovernable manner.

Melancholia differs materially from the first (mania proper), in being connected with depression instead of excitement. Delusions may not always be present, or, at least, not be observable; the sufferer is gloomy and the prey to unhappy and desponding thoughts, which often lead to suicide; he is sleepless, refuses food, often under the delu-

sion that it is poisoned. The delusions and hallucinations may assume an infinite variety of shapes ; they are often of a religious character, and very frequently connected with an idea of undergoing persecution. This latter delusion is very common, and under its influence the sufferer may resort to homicidal violence toward those whom he may imagine are his enemies. He should, therefore, be constantly watched.

This form of mental disorder rarely exists in an uncomplicated form ; it is apt to be alternated with fits of excitement (mania). The physical characters of melancholia are quite characteristic. "The patient, if a female, is dirty in her habits, soiling her clothes, and paying little attention to her appearance. With disordered hair and averted eyes the melancholic sits by herself, lost in her own reflections, although there are some who are communicative and loquacious." "The face is pinched and wan, and unnaturally pale ; the eyelids droop and the facial folds are dependent ; the lips are bloodless ; the pupils are dilated, and everything indicates inaction ; the hands are livid and hang idly, and the maintenance of a fixed position, sometimes for hours at a time, is characteristic of the intellectual torpor" (Hamilton).

Monomania.—This form of insanity has received other names, such as paranoia and primary delusional insanity. "The patient, in the simplest form of the disease, becomes possessed of some single notion, which is alike contradictory to common sense and to his own experience" (Husband). Sometimes it may have reference to some fancied bodily disease, as where he believes he has a snake or a lizard in his stomach ; or, as in the case of the woman

mentioned by Esquirol, who had hydatids in the uterus, and who believed that she was pregnant by the devil.

Moral Mania.—The title "moral mania" has been assigned, by Dr. Ray and others, to those cases of mental disturbance which, in the language of Prichard, "consist in a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions, without any notable lesion of the intellect or knowing or reasoning faculties, and particularly without any maniacal hallucinations." There is considerable diversity of opinion among writers as to the existence of moral insanity as a distinct variety of mental disorder. Some deny its existence as such, and assert that there can be no derangement of mind, without the intellect being affected. Such authorities are disposed to regard the merely moral perversions above alluded to as evidences of a moral obliquity, showing an excessive perverseness of character, rather than a derangement of mind. What has been termed emotional insanity, in modern times, partakes of this character. It must certainly be rare that any person becomes suddenly affected with an insane homicidal impulse; and unless it can be clearly shown that the culprit had exhibited previous unequivocal signs of insanity, or had a strong heredity thereto, such a plea as that of emotional insanity is not likely to be allowed. Unquestionably, the moral faculties are perverted in insanity, often, to appearance, more decidedly than those of the intellect; but it is rare, if ever, that they are exclusively deranged. The manifestations of a disordered mind may assume an almost endless variety of forms, doubtless dependent somewhat on the natural disposition or mental conformation of the patient. In some, the intellectual perversions will be more pronounced; in others,

disturbances of the moral faculties, affections, and sentiments are more obvious. Hence, it would be highly dangerous to pronounce a person insane unless there was some evidence of intellectual disturbance along with exhibitions of a depraved moral nature. It would be offering an excuse, or at least a palliation, for all sorts of moral obliquity.

The law does not recognize moral insanity as an independent state; "hence, however perverted the affections, moral feelings, or sentiments may be, the medical jurist must always look for some indications of disturbed reason" (Taylor). Although, according to Dr. Prichard, there are two forms of insanity (moral and intellectual), in law there is but one—that which affects the *mind*.

The term "partial moral mania" has been assigned to such cases of mental action as are manifested by certain forms of moral perversion, when only one or two phases of the moral powers are deranged. Different names are employed to designate these.

Kleptomania, or a propensity to steal, as shown in persons of excellent moral character in other respects, and whose easy, and even affluent, circumstances preclude the idea of want as a motive inciting to the crime. Some kleptomaniacs appear to be sensible of their fault, and are ready to confess and lament their unhappy propensity. There are, however, cases of so-called kleptomania in which there is a perfect consciousness of the act, and of its illegality; where the article stolen, although of trifling value, was yet of some use to the person; where art and precaution were employed in the theft; and where there was, subsequently, a denial of the act, or some evasive excuse. Of such persons it might more properly be said that their organ of secretiveness was

very largely developed. In a trial of a case of this kind it must be shown that the prisoner was incapable of understanding that the particular act in question was a wrong one. Otherwise, the whole class of thieves might equally urge the plea of insanity as a palliation of their crimes.

Pyromania.—A propensity or impulse to set fire to everything—houses, barns, churches, etc., without any motive. Hamilton speaks of it as being often connected with a variety of epileptic insanity. It is rare to find this moral perversion disconnected with other morbid impulses, especially homicidal or suicidal. A well-known historical instance of pyromania is that of Martin, who attempted to set fire to York cathedral. Many cases of so-called pyromania will be found, on investigation, to originate in personal grudge or revenge.

Dipsomania—Responsibility of Drunkards.—By this term is understood that form of insanity which manifests itself in a craving for alcohol—a craze for drink. It differs from the habitual desire for liquor of the ordinary dram-drinker in the fact that there are distinct remissions of the disease, during which there is not the slightest longing for drink experienced, but rather a loathing for it; but when this interval has passed away, the inordinate desire returns, and the unhappy victim will plunge into violent excesses, often frequenting the lowest taverns, and spending days and nights in literally saturating his system by drinking enormous quantities of brandy and other spirits. During these excesses the person shuns all society, and remains often secluded for many days and even weeks.

As regards the responsibility of drunkards, opinions differ. There can be no question that where the mind has become completely weakened by habitual drunkenness the

law would infer irresponsibility, unless it was clear that at the time of the act the person was fully aware of its nature and criminality. In a case of complete inebriety, where there is entire loss of consciousness, the individual is incapable of giving a valid consent; consequently, any deed or contract then executed would be invalid; but if the intoxication be only partial, so that the party knew what he was about, the act or deed would be held to be valid. A confession made by a partially drunken man is legally admissible as evidence against him, provided it is corroborated by circumstances.

The criminal responsibility of drunkards is more rigidly regarded by the law than their civil responsibility. Thus, murder committed by a drunken man is not extenuated because his brain may have been crazed by drink, if voluntarily induced on his part. If it can be shown that the drunkenness has produced a disease of the mind to such an extent as to have deprived him of a consciousness of the illegality of the act, then his irresponsibility must be admitted. A mitigating circumstance in such a case would be, if it could be shown, that the prisoner was not actuated by malice or grudge against the deceased, but had killed him while under the effects of alcoholism.

Although drunkenness does not excuse crime in the eye of the law, yet the insanity which may result from habitual drunkenness does certainly confer irresponsibility. So, likewise, it has been decided in some cases of *delirium tremens*, when the brain is temporarily diseased, so as to render the individual incapable of reason.

Homicidal Monomania.—In this form of madness the propensity to homicide is very great. There may, or may not, accompany it some intellectual aberrations; but the

characteristic feature is an uncontrollable impulse to take life,—often of those dearest to the unhappy victim,—actuated by some delusion which has, perhaps, been preying upon his mind for months before, but only now suddenly breaking out. Many striking cases of this form of insanity are recorded in the books, all, however, evincing other unmistakable signs of intellectual disturbance.

The following suggestions, taken chiefly from Husband, may aid in forming a diagnosis of the existence or non-existence of this form of insanity :—

1. Inquire into the previous history of the person : Was he morose, melancholic, apprehensive of impending evil, etc.? Had he previously received a fall upon his head, or been otherwise injured? Such a homicidal propensity rarely, if ever, manifests itself suddenly for the first time, like a flash of lightning out of a clear sky ; it is almost invariably preceded by other symptoms of mental disturbance, and usually of a melancholic character.

2. Ascertain the presence or absence of a motive—a most important factor in the responsibility of the accused. Often the real motive may be so deeply hidden in the breast of the culprit as to be completely concealed from the view of others, and scarcely recognized by himself.

3. A number of victims may be sacrificed at one time by the madman ; the ordinary murderer, on the other hand, seldom sheds more blood than is necessary for his success.

4. The conduct of the accused before and after the crime : the insane man usually makes no attempt to escape, but rather glories in the bloody deed, assigning his conduct to a divine or spiritual impulse.

5. The character of the victims. Not infrequently the madman destroys those who were the dearest to him while

he was sane, and for whose destruction he could have had no conceivable motive.

Suicidal Monomania.—This form of insanity displays itself by the prominent idea of self-destruction. Considerable diversity of opinion exists upon the question whether suicide is always to be regarded as evidence of insanity. Probably in the majority of cases, suicide is to be directly ascribed to insanity; but there are numerous instances where the act of self-destruction is deliberately perpetrated with a distinct motive and for a purpose. Suicide was at one period of the world's history regarded as rather a praiseworthy act on the part of persons wearied of life. Philosophers, poets, statesmen, generals, and moralists believed in it and practised it. Even at the present date it exists under national sanction in India and Japan. In our own times and country we have almost daily examples of deliberate suicides for whom the plea of insanity could never be urged. Moreover, the laws of most modern civilized countries regard suicide as a crime, which they could not consistently do if it was merely the manifestation of disease (insanity). Consequently, the argument is unanswerable, that many cases of suicide are the result of a perfectly sane and deliberate purpose acting upon the unhappy victim, and leading him to prefer death by his own hand rather than endure the miseries of his present existence.

The almost uniform verdict of coroners' juries in cases of suicide—"death by his own hands, while laboring under temporary insanity"—would seem to give some weight to the popular idea that suicide was always the result of insanity; but this is doubtless to be ascribed to a natural

desire on their part to soften down as much as possible the terrible nature of the death, in consideration of the feelings of the surviving relatives.

In cases of true suicidal mania it may happen that a latent delusion, often assuming the form of hallucination, may have been haunting the victim for months before the perpetration of the fatal act; while in other instances, the impulse is sudden and apparently unpremeditated. Even in the latter case it will usually be found, on careful examination into the previous history of the person, that there were some former manifestations of mental disorder. The case of the barber (mentioned by Sir C. Bell) who cut his own throat immediately after hearing a surgeon, whom he was shaving, describe the proper mode of performing that deed, illustrates the suddenness of the impulse in some cases of suicide; but it is possible that the mind of this man had been frequently dwelling upon this subject previous to the commission of the deed.

It is well understood that the law does not regard suicide as evidence of insanity, so that the validity of a will executed by one who subsequently takes his own life is not affected thereby.

The relation of suicide to life insurance is one of great practical importance in a medico-legal point of view. The policies of most life insurance companies, until very recently, contained a clause to the effect that the policy became void if the insurer should "die by his own hand"—making no distinction whatever between a *felo-de-se* committed deliberately and intelligently and a suicide resulting either from the acute delirium of fever or from a more chronic form of mental disease. Most assuredly, if regarded from an equitable standpoint, the policy should not be forfeited under

these latter circumstances, any more than if the death of the insured had been caused by apoplexy or by any casualty. How absurd it would seem for any company to make its insured responsible for that diseased mental condition which may culminate in an insane act of self-destruction, any more than for an attack of phrenitis, arachnitis, or typhoid fever, in all of which there may be acute delirium, driving its victim to an act of suicide! The line should be sharply drawn, in cases of life insurance, between intelligent suicides and insane suicides—the former being held responsible for the act of self-destruction, and, therefore, vitiating their policy; while the latter are to be regarded as irresponsible, and consequently not vitiating their policies. Any other ruling seems unjust. In point of fact, however, nearly all the life companies have dropped both suicide and intemperance as disqualifying causes for non-payment.

Just here we should not lose sight of the very important distinction between doing an act intentionally and doing it intelligently. The insane person, equally with the man of sound intellect, commits the suicidal act intentionally, *i. e.*, he cuts his throat, shoots himself with a pistol, drowns, or hangs himself, intending to take his own life thereby; but there is this all-important distinction between the two: the sane man does the deed intelligently as well as intentionally, fully aware at the time of the illegality of the act and of all of its consequences both here and hereafter. The insane man, on the contrary, commits the act with his mind not in its normal equipose, but swayed by an insane delusion.

There is a form of suicide which might give rise to considerable casuistry in cases of life insurance: in which a person in the habit of using powerful drugs, such as laudanum

or chloral, for medicinal purposes, takes a very large dose while in a state of intoxication, and dies. In such a case the act of self-destruction, not being intentional, could hardly be deemed felonious, and therefore not coming within the statute. But, on the other hand, as drunkenness is not a legal excuse for homicide, it might be made to affect the question of suicide also, which thus, under the circumstances, might be held as felonious killing.

As remarked by Taylor, if suicide is in all cases the result of insanity, the act ought to be more frequent among the insane. Experience does not favor this idea. The report of the British Commissioners of Lunacy for 1850 shows that out of 15,079 persons that year confined as lunatics, there occurred only eight suicides.

The suicidal tendency, or impulse, appears at times to assume an almost epidemic tendency in a community. Imitation has, undoubtedly, much to do with this, especially when the mode of self-destruction adopted and the attending circumstances were of a peculiarly sensational character. Thus, a second and a third suicide took place in rapid succession, soon after the first, by jumping from the top of the monument in London. The same thing occurred in Paris from the Napoleon monument. Dr. Forbes Winslow states that "some years ago a man hung himself on the threshold of one of the doors of the *Hôtel des Invalides*. No suicide had occurred in the establishment for two years previously; but in the succeeding fortnight five persons hung themselves on the same cross-bar, and the governor was obliged to shut up the passage." The tendency to suicide seems to be hereditary in certain cases, extending through several generations. But in all these instances there were other unmistakable evidences of a deranged mind.

General Paralysis of the Insane.—This affection, known also as "paretic dementia," is a disease of the brain, characterized by both mental and motor symptoms. Its approach is gradual and insidious. It often follows alcoholism and syphilis, and likewise mental overwork of any kind—any cause that occasions a continuous overstrain, up to the point of exhaustion, upon that portion of the cerebral mass in which mentalization especially resides. Clouston shows this function to be especially located in the gray substance of the convolutions. Its outer layer or rind is most delicately constituted, has far more blood and more minute cells than any other portion of the brain, and on the whole may be regarded as the most important factor in mentalization, being, in fact, the mind-tissue. General paralysis is a disease of this outer layer of the cerebral convolutions—of the mind-tissue, in fact. "It is essentially a death of that tissue. It is equivalent to a premature and sudden senile condition—senility being the slow physiological process of ending, general paralysis the quick pathological one. The causes of it are causes that have exhausted the trophic energy by over-stimulation."

It may begin with scarcely perceptible alterations in manner, fretfulness, irritability, and carelessness in habits, which are soon succeeded by ridiculous boastings of possessions and personal abilities (delusions of grandeur). These delusions assume various forms and expressions; sometimes it is enormous wealth of money and jewels; again, it is herculean strength of body, or wonderful mental capacity; again, it may take the form of extraordinary sexual capacity. Along with these there is the most foolish extravagance, purchasing the most useless articles and throwing away money with the most reckless prodigal-

ity. "At this time there will be noticed a loss of muscular power; at first, the tongue will tremble when protruded; then the lips become tremulous, and the corners of the mouth uneven; the speech is clumsy, and there is great difficulty in pronouncing the labial and lingual consonants" (Hamilton). The pupils are apt to be unequally dilated, or they may both be much contracted.

As the disease advances, the gait becomes unsteady and trembling. Vision is also impaired, as are also the other senses. Fits of violence often alternate with a melancholic condition, and epileptic and hemiplegic attacks may complicate the case toward the last; but, as has been already suggested, these may be indications of some organic disorder which occasionally accompanies the disease.

Among the frequent accompaniments of this form of insanity, Clouston alludes to the "insane ear" or *hematoma auris*, a bloody, gelatinous swelling of the ear, usually the result of a blow upon that organ, although sometimes of spontaneous origin. Its occurrence is always an unfavorable prognosis in this and other forms of insanity. "It is connected with arterial degeneration in the branches of the carotid artery. The contents of *hematoma auris* are like the extravasations under the dura mater in *pachymeningitis hemorrhagica interna*, a disease that is liable to occur in precisely the same class of persons."

There are periods of remission in general paresis, during which the individual appears quite sane. These may last for weeks or months. During these intervals the question of his testamentary capacity may be raised, which, of course, would have to be decided according to the actual mental condition of the patient. If under an extravagant delusion extravagant and unjust bequests were made, these should,

undoubtedly, be set aside, as being the offspring of a deranged mind.

The prognosis in general paresis is always unfavorable; the disease progresses to a fatal termination, though not always rapidly.

Dementia.—This term is used to define the condition manifested by a decay of the mental powers. Commencing with a gradual enfeeblement of the mind, it may terminate in its total extinction. It differs totally from mania in being attended by a lack of ideas, while the former is characterized by an exuberance of ideas, although these are confused and incoherent. Dementia is essentially a disease of depression; mania, one of excitement. It may follow acute mania or melancholia, or result from cerebral organic disease or injury, and it is a frequent accompaniment of old age (senile dementia). Its most striking symptom is loss of memory, this faculty being the first to show signs of decay. This progressively increases, until everything seems to be forgotten by the patient, even what he has seen, or heard, or done only a few moments before.

The general mental feebleness is further manifested by the "wavering play of worn-out emotions, incoherence, and half-formed and varying delusions" (Hamilton). The delusions are of a suspicious character; the patient is undecided, childish, and silly in his manners; his conversation is incoherent; he will repeat words or sentences without any meaning; he manifests neither partiality nor aversion to former friends or acquaintances; he moves about aimlessly for hours, or may remain for days in the same attitude. There is often a strong disposition exhibited for hoarding up useless articles, as if they were of great value. The

countenance is generally pale, vacant, and without expression; the look vague and uncertain, and tears are often easily shed, from the slightest cause.

Secondary dementia, following disease of the brain, is usually gradual in its approach, the decay of one mental faculty following another, and accompanied, also, with progressive physical weakness. Such cases are popularly known as "softening of the brain;" and there is probably no sadder spectacle to witness than the gradual decay, through disease, of both mind and body, in one whose former brilliant intellect is slowly but surely giving place to the fatuity of dementia.

Dementia is thought to follow mania more frequently than melancholia; and although it may seem to resemble the latter form of insanity in some of its features, it differs from it in exhibiting less coherence of ideas, and less ability to keep up the continuity of the delusions.

Senile dementia is usually marked by a failure of both the bodily and mental powers; it exhibits itself by loss of memory and childishness. The person is cross and petulant, uncertain in action, careless, and often filthy in habits; wandering about aimlessly; often foolishly extravagant. The patient gradually sinks into a state of complete fatuity, and finally dies of exhaustion.

Puerperal Insanity.—This form of insanity attacks women at a period varying from a few days to several weeks after delivery. It is said to occur most frequently before the cessation of the lochia. It is usually attended with the appearance of albumin in the urine, and with the interruption or suppression of the milk and lochia. The disorder may assume any form of mania, from the grave to

the gay, loquacious, taciturn, correct or foul in talk, attended with delusions of a religious character, or of persecution. The patient is apt to forget recent events and not to recognize persons. Her infant is either disregarded, or becomes the object of stealthy destruction. Instances are reported of the most horrible murders of their offspring by mothers suffering under this form of insanity. Crimes of this character are sometimes committed from a seemingly sudden impulse; whilst, in other cases, they may be preceded by torturing doubt; and the very sight of the child has aroused the almost invincible desire to murder it. Dr. Reese notes the case of a lady who had completely recovered from her first confinement, and was able to go out. One day, several weeks after the birth of her child, she was visiting at a friend's house, when, all of a sudden, she broke out into the most violent paroxysm of mania, requiring bodily restraint. She took a strong dislike both to her husband and child. She was treated in different asylums for about one year, when she completely recovered, and has continued well ever since, having also given birth to another child. Women suffering from puerperal mania are apt to commit the most unexpected crimes, which, at times, may be misunderstood by juries, and may be mistaken for instances of intentional infanticide. Fortunately, however, for the diagnosis of the case, the crimes are brutally executed, and often more than one person is murdered, so that no doubt can be raised as to the real condition of the patient.

Somnambulism.—The degree of responsibility for acts committed in sleep-walking, or somnambulism, is on a par with those committed in delirium tremens—*i. e.*, there is no

responsibility. In the "unconscious cerebration" during sleep it is presumed that intention and malice, the chief ingredients of crime, are wanting. So, also, in the case of a person half-awake, suddenly aroused under the effect of a delusion of a dream, who may make a murderous attack upon his wife or child, supposing he is defending himself against a mortal enemy, no criminal responsibility would be imputed to him.

Epileptic Insanity.—The majority of epileptics sooner or later show mental deterioration. According to Esquirol, out of 339 epileptics in the Salpêtrière, 12 were monomaniacs; 64 were maniacal; 34 were furious; 145 were imbecile or demented, 8 were idiotic; 50 were habitually rational, but with loss of memory, exaltation of ideas, sometimes a temporary delirium, and a tendency to dementia; 60 had no derangement of intellect, but were very irritable, irascible, obstinate, capricious, and eccentric (Ray). An investigation of the epileptic wards of any large hospital will give similar results. An epileptic may be the victim of mania, melancholia, paranoia, or paretic dementia. Any form of insanity may, in fact, be associated with epilepsy, but a certain type of mental disease is especially regarded as epileptic, and this may become of great forensic importance. It is usually studied in its relation to the motor paroxysm or fit, and from this point of view can be subdivided into 1, post-epileptic insanity, which follows the convulsive attack; 2, pre-epileptic insanity, which precedes the attack; 3, the psychical substitute of the attack; 4, insanity occurring in the interval between the attacks.

The psychical disturbances which occur before, after, or as the equivalent of the fit, may be of much the same character, although post-paroxysmal outbreaks are most

likely to be maniacal. Preceding the fit the epileptic frequently shows great irritability, moroseness and suspicion. Mann well describes a typical post-epileptic condition as follows: "After a fully-developed seizure the patient usually sleeps profoundly for a variable period, and on awakening is in his former condition, except that he feels sore and fatigued; in some cases automatic movements are made before consciousness returns. A man may have a fit in the street, and after it is over may get up and walk a considerable distance without any perception of his surroundings; when he comes to himself he finds that he is in a neighborhood quite unknown to him. Whilst in this condition he may perform a variety of actions of a purposive nature which demand complicated movements for their execution. The actions performed are determined by the influence of past co-ordinations on the motor centres acting in the absence of the restraint imposed under normal conditions by the highest controlling centres, the latter being in a state of passivity from exhaustion. Many of these actions present all the appearance of volitional movements, and yet the individual, both at the time and afterward, is quite unconscious of having performed them; although described as automatic, they are probably initiated by a slight peripheral stimulation, or by one of internal origin."

The remarkable affection of memory and consciousness known under such names as periodic amnesia, periodic asynesia, double consciousness, and alternate consciousness, is allied to epilepsy. The medico-legal problems which arise in connection with those suffering from this disorder belong to the subject of epileptic insanity. Medical literature has furnished us with striking illustrations of this disorder, some worthy of credence; and novelists and

newspapers have woven from such phenomena stories of thrilling interest, in which, however, the facts, as a rule, are far from keeping pace with the fiction. Among epileptics, periodic amnesia, or an allied state, is observed in a variety of forms. Instead of passing into a maniacal state, many epileptics, after a fit, if sleep does not ensue, become dazed, confused, or somnambulistic. Others have attacks which have been described as epileptic automatism, concealed epilepsy or masked epilepsy, in which are performed unusual, grotesque, or vicious acts, which may bring the persons within the purview of the law. Among such acts are undressing or urinating in public. It will, of course, often be extremely difficult to convince authorities that such a performance is not criminal.

In some cases crimes are committed by those who are probably epileptic, or at least sufferers from some of the epileptoid affections of consciousness and memory, but who are not known to be thus afflicted. A remarkable case has been reported by Yellowlees. The patient had a clear history of somnambulism and night-walking from when he was a mere lad until the time when he committed the crime for which he was tried for his life. He became more and more subject to somnambulistic seizures as he grew older, and these attacks were accompanied with great terror and with the appearance of visions of wild beasts and other horrible things. Sometimes he would tear his wife and child from the bed while fiercely chasing wild beasts through the room, at the same time striking with anything upon which he could lay his hands. In one of these terrible paroxysms he hurled his child with such force against the wall that it fell dead. He was tried for his life, and the jury found the man was unconscious of the nature of the

act which he had committed, by reason of a condition arising from somnambulism, and that, therefore, he was not responsible. When put on trial the man entered the following strange but just plea: "I am guilty in my sleep, but not guilty in my senses."

It is probable that many epileptics have been punished for homicide, theft, arson, assault, and other crimes committed without their true volition, although the acts were apparently purposive; but it is often a task of extreme difficulty to decide as to the insanity of an epileptic at the time of the commission of a crime. Zacchias contended that epileptics should not be responsible for any acts committed within three days of a fit, before or after; but no rule can be invariably followed. It is not correct to conclude that the mere existence of epilepsy is sufficient to establish unsoundness of mind and irresponsibility; but each case should be decided on its own merits, after a careful investigation of the family and previous history of the accused and of the circumstances surrounding the crime.

It is altogether probable that transitory mania or transitory frenzy, so called, is sometimes epileptic in origin, although the claim that has been made that this form of insanity is always cerebral epilepsy cannot be maintained. When a crime has been committed in an attack of transitory fury or of apparent passion, it is important to inquire closely as to the existence of epilepsy.

Post-mortem Lesions in Insanity.—Modern research has done much to elucidate what was formerly very obscure touching the true pathology of insanity. In every case of true insanity, especially in the chronic form of the disorder, there are pathological changes produced in the brain, although these may, at times, be too subtle and recondite

to be discovered by our present means of research. If it be true that every abnormal alteration of function in an organ involves, for the time, an alteration of structure (although this may not always be capable of demonstration to the senses), it would seem most reasonable to refer those abnormal displays of the intellectual and mental functions which accompany insanity to some structural change in the different parts of the cerebral structure.

It is a most vague and unsatisfactory mode of expression to speak of a diseased mind, as if the incorporeal, impalpable entity which we term mind was the real seat of disease; whereas the true condition would seem to be that as the mind can only act, in our present state of being, through the brain, a diseased condition of the latter organ must necessarily affect and distort the different mental manifestations. The doctrine that insanity is due to diseased physical media seems to be most consistent with sound philosophic and physiologic views—and we may add, also, with sound therapeutic views. For, as has been well urged, on what other grounds do we administer material remedies in cases of insanity, except with the expectation that these remedies will remove disease from the media? When this is accomplished, the manifestations of the mind's operations again become normal and natural.

On the other hand, it must be remembered that extensive disease of the brain may exist, and sometimes exhibit pathological changes very similar to those accompanying insanity, without marked indications of this disorder. Why this should be so we are unable distinctly to say. Heredity and other occult causes may produce effects whose operations we are not yet prepared fully to understand and explain.

It is a popular idea that the largest brains are found in persons of the greatest intellect; this is far from the truth, as one of the largest on record belonged to an idiot.

In an autopsy of the brain in a case of insanity, the points for consideration are its size, weight, and configuration, the appearance of the convolutions, depth of the gray substance, and marks of recent or chronic disease. In general, it may be stated that, in chronic cases particularly, the appearances commonly met with are thickening of the cranial bones, close adhesion of the dura mater, congestion of the pia mater, with opacity and thickening of the arachnoid. There is also general fullness of the blood vessels, with remains of old cysts, hardened deposits, or even abscesses in the cerebral substance; alterations in the form and structure of the convolutions and depth of the gray matter; also effusions of blood and serum, the latter into the ventricles, together with alterations and atrophy of the nerve-cells.

In Idiocy and Imbecility the brain is usually smaller than natural (although there are exceptions), with partial atrophy of the convolutions, particularly the frontal. There is also, generally, a want of correspondence between the two lobes. The fissure of Sylvius is also, according to Luys, usually enlarged, extending much farther back than in the normal brain. In these cases there has been a true arrest of development, depending upon some defect in the cortical substance, from which intellectual nutrition should have been supplied.

In Acute Mania the most common lesion is intense hyperemia along the whole margin of the gray substance of the convolutions and also in areas below them. This active congestion is not, however, to be regarded as the primary cause of mania; otherwise, this latter disorder would

frequently be the sequence of meningitis. According to Luys, the vessels of the *corpora striata* are most dilated and engorged.

Clouston describes a singular pathological condition, noticed in a case of acute mania, consisting of a copious deposit of an abnormal material over the entire convolutions, "chiefly in their inner layers, and extending, in some places, into the white substance, and replacing at least two-thirds of the gray substance. In many places it was deposited in masses around the arteries." But that such an abnormal deposit is necessary to produce all the symptoms of violent mania is fully disproved (as the author remarks) by the fact of its entire absence in other numerous cases.

The pathological changes exhibited in chronic mania are not pathognomonic. We generally find thickening of the membranes, some atrophy of the convolutions, long congestions, together with disease of the coats of the vessels, with occasional spots of softening. There is, usually, thickening of the bones of the skull, with occasional excessive bony deposits on the inner surface.

In Melancholia, "Luys found, in several cases, great hyperemia of the gray substance of the third ventricle. This gray matter on the cortex of one of these patients was thin, and most of the convolutions were pale, with irregular vascular arborizations. In some cases of profound melancholia with stupor the brain was completely exsanguined, the white substance deprived of vessels, with atrophy of the cortex" (Hamilton).

The pathology of epileptic insanity, like that of epilepsy, yet remains very obscure. According to Dr. Clouston, who has examined numerous cases of this disorder, "there

is no special lesion or abnormality." Among other lesions, he has found "spiculæ of bone from the skull-cap and membranes pressing into the convolutions, apoplexies, destructive lesions of the brain of all kinds and in all places, embolisms, fatty and otherwise, adhesions of the pia mater of the convolutions, the marks of traumatic injuries of all kinds and in all places, unequal hemispheres, and congestions of all sorts and in all places." This author does not believe that the source of irritation, in epilepsy, exists in the pons and medulla oblongata, but thinks that an irritation of the motor area of the convolutions is far more apt to cause it than one anywhere else.

In insanity due to syphilis we may expect to find a variety of pathological changes, consisting, chiefly, in thickening of the bones of the cranium, and of the membranes which adhere to the bones and to the convolutions; atrophy of the convolutions, adventitious deposits in the gray matter; softening and disappearance of the white matter; tumors (syphilomata) in different places; hypertrophy of the coats of the arteries, obliterating their lumen, thus causing atrophy of the structure. There is believed to be a tendency in syphilis to attack the brain, after having lain latent for many years. Moreover, it appears that the tendency of the disease toward the nervous system is in the inverse ratio to the development of primary and secondary symptoms.

In senile dementia the most usual pathological lesions, according to Clouston, are localized softenings of the cerebral structure, the result of cutting off the blood supply through embolism; atheroma of the arteries, also a marked atrophy of the whole brain or of considerable portions of the convolutions. The membranes are commonly thick-

ened, and the cerebro-spinal fluid milky, superabundant, and full of microscopic débris. The large nerve-cells are degenerated and disappearing, along with atrophy of the smaller cells and nuclei.

MEDICO-LEGAL RELATIONS OF INSANITY.

The duties of the medical practitioner in connection with cases of real or alleged insanity involve grave responsibilities on his part, and require the exercise of judgment and caution. The most important of these duties are the following:

1. Assuming the responsibility of treating cases at home, assigning them attendants, restricting their liberty, and preventing their attending to their ordinary business. This is a serious undertaking, and the physician will do well, in such cases, merely to act as an adviser, but *to assume no responsibility* in the restraint; this should devolve upon some relative of the patient.

2. To sign the proper certificate for the admission of the alleged insane patient into a public or private asylum. This measure may become necessary both for the good of the patient and for the safety of the public; but as interested relatives and others might possibly combine to commit a sane person into an asylum, and the physician, in such a case, is liable to be imposed upon, he should exercise the greatest caution and judgment before giving his signature; otherwise he renders himself liable to heavy punishment, by an action at law, for false commitment. The form of certificate is fixed by statute, and no other is valid in the United States. This must be signed and sworn to by one or more respectable physicians, who have previously witnessed and examined the patient. In Pennsylvania, for

instance, the law requires the signatures of two physicians who have been in practice for at least five years, and who have examined the patient separately within one week of their signatures, and who testify, under oath, of the necessity of placing him (or her) under the restraint of an asylum. The person applying for the admission of the patient must also sign a responsible bond, setting forth their reasons for the request, giving a history of the patient's symptoms and probable cause of the attack. The physicians who sign the certificate must have no connection with the hospital, nor be related by blood or marriage to the patient.

Before certifying to the insanity of a patient under any circumstances, the practitioner should first conscientiously determine the *fact* of the insanity; and, for this purpose, he is compelled to make a careful personal examination of the patient. This may require several visits in some cases, since the cunning of the lunatic may at first baffle the physician. Then as to the "setting forth the facts" upon which the physician's opinion is based, great care and experience are required, in order to give only such "facts" as are really demonstrative of the alleged mental disorder.

3. In the discharge of lunatics the same caution and judgment are required on the part of the physician. Patients sometimes obtain their discharge from an asylum, contrary to the wishes of the superintendent, on a writ of *habeas corpus*, and they not infrequently bring an action against both the superintendent and the physicians who signed the certificate for false detention. But generally they are removed by their friends, when sufficiently recovered, at the discretion of the superintendent. In this country there is no legal restriction on the liberation of the insane on their recovery, except in cases of homicidal, or

otherwise dangerous, lunatics who have been confined by order of the courts.

4. Medical men are often called upon to give evidence as to the existence, or not, of insanity in a criminal under sentence of death, in order to stay execution. For this purpose it is usual for the court to appoint a commission of three or more persons, the majority experienced physicians, to determine the question.

5. When a defense of the prisoner is based upon alleged insanity, the court summons experts, whose duty it is to determine, as far as possible, the patient's mental condition both before and at the time of the commission of the crime.

6. In civil cases the physician is constantly appealed to, as, *e. g.*, to determine the testamentary capacity of one making a will, or signing a contract, or contracting a marriage, or transacting ordinary business. As regards testamentary capacity, it is understood that the law requires a less amount of mental capacity for making a will than for managing property or enjoying personal liberty. Patients in asylums have made wills which the courts have sustained. Patients with insane delusions that did not affect the provisions of the will, and which were just and reasonable, have been held by the highest tribunals to have made good wills. Thus, a person suffering from religious melancholia, under the delusion that he had committed the unpardonable sin, but manifesting mental soundness in other respects, as indicated by his correct business transactions, undoubtedly is possessed of testamentary capacity. His insane delusion does in no wise affect the matter at issue—viz., his ability to dispose of his property. But it would be altogether different if his delusions took a different shape; if, for example, he believed that one of his

children had attempted to poison him, and, in consequence of this false notion, he had disinherited that child ; in such a case—inasmuch as the delusion may have directly affected the provisions of the will—they should be regarded as impeaching the testamentary capacity. Under such conditions he could not be considered as possessing a disposing mind. The most absurd and eccentric wills have been held by the courts to be valid, where such wills were shown to be in perfect accordance with the whole former life and character of the eccentric (but not insane) testator.

In order to make a valid will, the law requires that the testator should be sane at the time he makes it. Hence, temporary drunkenness, the delirium of a fever, narcotism, and similar conditions would, for the time, disqualify him. But a person may be suffering from the effects of a powerful poison—arsenic or strychnin, for instance ; provided his brain is not affected so that his intelligence is impaired, his will made under these circumstances will be perfectly valid. The question has been raised of the validity of a will made by a person suffering from typhoid fever ; the answer should certainly be affirmative, provided he was not delirious at the time. In an English case it was held that neither erysipelas nor fever would invalidate a will, but that the stupor and drowsiness induced by them would.

As regards paralysis, it has been settled that this is not sufficient to invalidate a will, even if it be accompanied with aphasia or loss of speech, always provided the mental powers were good. The same is true of the collapse of cholera, where the patient is unable to speak from exhaustion, but where the mental powers continue unimpaired.

In epilepsy, unless it can be proved that the repeated attacks have affected the mind, so as to have completely

unhinged it, it has been decided that the patient has a perfect testamentary capacity in the intervals between the paroxysms. The case of the Duchess of Manchester (1854) is one in point. She executed a second will about three weeks before her death. She had repeated attacks of hysteria and convulsions along with delusions. The attending physician deposed that on the day of executing the will, and for some days previous, the duchess had recovered her reason, and that at the time of signing it she was, in his judgment, aware of what she was doing, and that she voluntarily delivered it as her own act and deed. It appeared also that the disputed will was substantially such as the duchess had announced before that it was her intention to make. At the trial several medical witnesses gave their opinion that the duchess was of unsound mind, and, therefore, incapable of making a will. But the point at issue was—Was she at the time of executing the will in a competent state of mind? The jury found that she was competent, and that the will was valid.

When a physician is asked to examine into the testamentary capacity of a patient before executing his will, it will be well that the interview should be strictly private, or else in the presence of the nurse, or some one member of the family, in order to ascertain the true condition of his mind: whether it is free from the action of drink or narcotics; whether he properly understands the nature of the act he is to perform; whether he is influenced as to the manner of doing it by any insane delusions prompting him thereto; and, finally, whether any undue influence is being exerted over him from without. It may happen that in a private interview a dying man might disclose to his physician the fact of such an improper influence, from which he

was desirous of escaping, but which had become dominant over him in consequence of his weakness.

7. The medical man may be asked his opinion in reference to the propriety of contracting a marriage with a party who has been insane or who has an insane heredity. This is often a most delicate and responsible position for him to occupy. Undoubtedly, physicians will be generally averse to marriage when either party has been insane; certainly, if there exists a history of insanity in the family, the risk is very great. A sporadic case of insanity, depending on some special cause and perfectly curable, may occur in any family; this might be excepted from the advice above given.

8. Then, also, as to the proper training and education of children of insane or neurotic parents, medical advice is often very properly sought and followed. Such children should, of course, be brought up on strictly physiologic and hygienic principles. Pure air, simple but nourishing diet, plenty of out-door exercise, the avoidance of all improper excitement, especially toward the period of puberty, and the subordination of their intellectual studies to their physical health—these are the points to which the attention should be specially directed.

CRIMINAL RESPONSIBILITY—THE PLEA OF INSANITY AS A BAR TO CAPITAL PUNISHMENT.

There is no aspect of insanity of more profound interest to the medical jurist, nor of greater importance both to him and to the community, than that of responsibility in criminal cases. After clearing away much irrelevant matter that prevents a clear comprehension of the subject of criminal responsibility—divesting it of all its mere technicalities and subtleties—we come to the true test—mental disturb-

ance arising from disease. In the words of Dr. Bucknill: "The element of disease, therefore, in abnormal conditions of mind, is the touchstone of irresponsibility, and the detection of its existence or non-existence is the peculiar, and oftentimes the difficult, task of the psychopathist."

But the question immediately occurs—How is the existence of this alleged mental disorder to be determined? What are the tests of its presence in the criminal at the bar of justice? In England, formerly, the doctrine was "that every man was responsible for his acts unless he was totally deprived of his understanding and memory, and did not know what he was doing, no more than an infant, than a brute, or a wild beast." In the case of Bellingham, "the knowledge of right and wrong" in the abstract was the test of mental unsoundness; and as, in the opinion of the judge and jury, he was held to be capable of solving this metaphysical problem, Bellingham was duly hanged. Since the trial and acquittal of MacNaughton for the murder of Mr. Drummond, on the ground of insanity, the doctrine of the knowledge of abstract right and wrong has been changed to a knowledge of right and wrong in relation to the particular act of which the person is accused, and also at the time of committing it (Husband). But a step further has been taken in declaring "he must also have a knowledge of the consequences of the act."

The knowledge of the difference between right and wrong has been the test for years; yet it is unsatisfactory. No doubt many insane persons have committed acts which they knew to be wrong, and of the criminality of which they were at the time perfectly conscious; as they were also of their penal consequences. Some have been known to commit murder with the avowed intention of receiving

the punishment of death at the hands of the law, instead of inflicting it suicidally upon themselves. Dr. Maudsley criticizes the above "test" very truly when he says: "Here is an unhesitating assumption that a man having an insane delusion has the power to think and act in regard to it reasonably; that he is, in fact, bound to be reasonable in his unreason, sane in his insanity."

The decisions in the American courts have generally been similar to those of England, the dominant idea being a knowledge on the part of the criminal of the wrong nature of the act in question—"its criminality, not only against the laws of man, but also against the laws of God and nature." The doctrine laid down by Mittermaier is thought by some to cover the ground more completely. He regards the will as the most important factor in the case. He rebukes the English jurists for their rigid adherence to the antiquated doctrine, that whoever can distinguish good from evil enjoys freedom of will, and retains the faculty (if he choose to use it) of framing his action to the requirements of the law. "A person who commits a criminal act, being fully cognizant of the nature of the law, and of the punishment to which he is exposing himself, may yet be of insane mind. The true test of irresponsibility should be, not whether the party accused was aware of the criminality of his action, but whether he has lost all power of control over his actions." According to Hamilton, "the true test, after all, is the condition of the will." With this Ordronaux substantially agrees when, speaking of criminal responsibility, he adds, in addition to the defendant knowing the nature and consequences of the act, and having a felonious intent in its commission, that "he had the power to choose between doing and not doing it; and, supposing

this power to be lost, it is lost solely through disease, and not through temporary inebriety or violent anger."

The above doctrine seems to be sound ; it is founded on psychologic principles, and certainly cannot be accused of bearing harshly or inhumanly against a prisoner. It places his irresponsibility for the criminal act exactly where it ought to be placed—on a distorted mind. Moreover, a thorough understanding of these views by medical experts, and a more general dissemination through the community of the important doctrine that insanity is a disease, and not a mere outburst of anger, or even a series of emotional acts, will contribute not a little to educate the people as to the reasonable and proper grounds to be taken in those cases of homicide in which the plea of insanity is urged.

Impulsive or emotional insanity, as it is named, is often urged as a defense for crime, especially homicide. Is the plea a sound one ? Can it be possible that an individual can be sane immediately before and immediately after the commission of an act, and insane only at the moment of its commission ? A well-known writer thus expresses himself : "I see no ground on which to rest a hypothesis of an impulsive insanity, or to justify an incorporation in our medical jurisprudence of such a form. I cannot conceive of a homicidal act, impulsive without motive, delusion, or passion, simply a so-called impulse to kill ; and a careful analysis of clinical cases under my own observation, as well as a large experience in the examination of criminals, sustains this view. Impulsive disease can not exist. The term impulse, used to describe certain acts of the insane, executed suddenly and without apparent premeditation, may be proper enough as qualifying a mental state during an act, as impulsive homicide, but this does not justify the

transposition into homicidal impulse. Such transposition would show, not that the acts were apparently unpremeditated and sudden, but that, in the mind there was suddenly generated a murderous impulse, an irresistible power, which, without the intervention of reason, or any intellectual act or motive, suddenly impels to the physical act. Man is not the prey to blind impulse." (Quoted by Hamilton.)

SIMULATED OR FEIGNED INSANITY.

There is probably no subject in medico-legal practice which causes the physician more trouble and anxiety than the disputed mental condition of an individual. If the question of feigned bodily diseases often occasions considerable difficulties, how much greater will be his perplexity and doubt when he comes to deal with the subtle workings of the mental operations. Insanity is not infrequently pretended by persons accused of criminal offenses, in order to procure an acquittal, or a discharge from prison. In the first place, when feigning is suspected, we should ascertain whether there was a motive for pretending to be insane. Remember that insanity is rarely, if ever, assumed until after the commission of a crime and the detection of the criminal.

A further important point is, to ascertain if the criminal deed was, or was not, an isolated act in the mental life of the culprit—whether it originated suddenly in his mind, like a flash of lightning from an unclouded sky, or "whether it was not rather the last link of a long chain of sinful, criminal desires, hopes, and acts." In other words, to ascertain if it was not just such an act as might have been expected from the culprit. This investigation is of the utmost importance, since it does not usually happen that a person should suddenly act in a manner diametrically

opposite to all his former character, without some powerful psychologic cause.

This inquiry into motive is often of primary importance in the alleged insanity of criminals. The motiveless character of a deed is very apt to impress us with a lack of good sense, if not of positive mental weakness, in its author. Hence, if we can discover a true motive for a criminal act, especially if the motive agrees with the disposition and character of the culprit (an important consideration), this would go very far to establish the responsibility of the accused at the time of the commission of the crime, despite all his affectation of insanity.

There is often great difficulty in getting at this motive. In some cases there is no apparent motive; but we should not be too ready to admit its absence, since it is indisputably true that there are as many different motives to illegal action as there are different characters; and what would be a powerful motive to one person might have no influence whatever over another, placed under different surroundings. "In order to recognize this fact, the inquirer must, in every case, place himself in the position of the culprit, and divest himself of his own ideas." * * * "No crime, be it what it may, is ever committed without a motive; and the character of that motive may be expressed thus: 'the conscious impulse to the illegal gratification of a selfish desire'" (Casper).

A third point in the detection of feigned insanity is to ascertain whether the culprit, in carrying out the deed of which he is accused, has acted according to any regular plan or not. In most cases, however, this is of but little diagnostic value, since many confirmed lunatics evince the most surprising adroitness in planning and executing

schemes for escape, or for enticing their victims whom they intend to murder.

One thing, however, should be remembered in this connection : generally speaking, in a case of real insanity the individual will, so to speak, break down before he is quite through ; that is, he will do or say something which will betray his mental debility. Thus, an insane patient in a private asylum near London, with the greatest artfulness managed to steal a piece of iron, with which he subsequently sawed through the bars of his windows, and brought to success his long-cherished plan of flight. These circumstances proved the calmest and most systematic deliberateness. But here his reason forsook him : after his escape, he ran straight to the Duke of Wellington's house, and announced himself as his eldest son.

A fourth point to be noticed in the diagnosis of a case of pretended insanity is, whether the culprit has taken any measures to avoid arrest or punishment. Whether, for instance, he had adopted any disguise in his personal appearance or dress, such as removing his beard or putting on a false one, dyeing his hair, etc., or making preparations for escape, or waiting for the darkness of the night for the perpetration of the deed. All such circumstances would create a strong suspicion that the accused pretty clearly recognized the responsibility of the deed. The really irresponsible criminal will usually evince a total apathy about the result, and will display a feeling of the utmost security, often exulting in the deed, which may even have been committed against one of his own immediate family.

A fifth important consideration in relation to the diagnosis is the peculiar condition of the intelligence of the accused as ascertained, on examination, to have always existed, or

at least for a long time previous to the commission of the criminal act (Casper). For example, a person may be claimed as insane, because of alleged feeble-mindedness, as displayed in inability to count, to read and write, to carry on a continued conversation, and the like; but all this may be satisfactorily answered by showing that the person has had no previous education whatever, and consequently no opportunity of learning any of the above matters. Hence the allegation of his being "silly," "childish," "simple," etc., can be of no avail as producing irresponsibility for his particular crime. Here the related facts must be ascertained in reference to the case in question—his family history, his mode of bringing up, his manner of life, etc., together with the relation of the deed for which he is accused to the sphere of his intelligence.

Another point to be noticed is the distinction between the hallucinations of the really insane and the alleged "voices" and "impulses" of the pretender, forcing him on to the commission of his crime. It may safely be asserted that, whenever hallucinations accompany real insanity, the latter will display itself by other unmistakable signs, so that by attentive watching we can generally succeed in distinguishing the genuine from the pretended.

A strong circumstance bearing on the detection of suspected insanity is the fact that, in a genuine case of the disease, the person will not admit that he is insane; while the pretender will use all his efforts to make you believe he is mad. So thoroughly is this the case that an impostor may be induced to perform any act, if it be casually observed to another in his hearing that the performance of such an act would furnish strong evidence of his insanity.

Mania is probably more frequently feigned than any

other form of insanity, from the popular notion that insanity is made up of violent action and vociferous and incoherent language. But mania seldom comes on suddenly without some obvious cause. A maniacal patient is equally furious by night and by day; an impostor sleeps. Real mania manifests itself equally when the patient is alone or in company; an impostor, only when he thinks he is observed. The peculiar restless expression of the eye of mania is hard to imitate. The pulse, temperature, state of skin, etc., of the genuine disorder cannot be assumed by the impostor. Dementia is more difficult to imitate. The discovery of any connected ideas, reasoning, or reflection, either by language, signs, or writing, would immediately show that the patient was simulating.

Occasional instances, however, are presented of a successful malingering in this line which baffle the detective skill of the most experienced examiners. Dr. Bucknill mentions the case of Warner, a notorious thief, who was sentenced to transportation for fourteen years. Two days after the trial he became apparently insane; he constantly made howling noises, was filthy in his habits, tore up his clothes, destroyed his bedding and other articles. He was, however, suspected of shamming and was detained in prison for three months. During part of this time it was found necessary to keep him in a straight waistcoat. At length a certificate of insanity was forwarded to the Secretary of State, and he was ordered to be removed to the Devon County Asylum. On admission here he was found to be in feeble health. He had an oppressed and stupid expression of face; he answered no questions, but was constantly muttering to himself, remaining in the same position for hours, either in a standing or sitting posture. He was now

not dirty in his habits ; he appeared to be, in truth, suffering from acute dementia. In three weeks' time he recovered his bodily health. This change was too rapid not to suggest the idea of deception, but the preceding symptoms had been so true to nature that it was still thought that the insanity had not been feigned. For a period of eight months he was well conducted and industrious and he showed no symptoms of insanity. At the end of that time he was returned to the jail to undergo his sentence, and within one hour after his readmission within its portals he was apparently afflicted with a relapse of his insanity. From this time, for a period of two years, this indomitable man persisted in simulating mental derangement. He refused to answer questions, walking to and fro, constantly howling, and refusing food for days together. He would keep beating at the door of his cell, tearing up his bedclothes over and over again ; he had a stupid expression of countenance, but he slept soundly. He became filthy in his habits, but was cured of this by the hot bath. He was often visited by the physician, who said he was a malingerer. After two years he suddenly gave up and acknowledged the deception.

CHAPTER XIV.

MALPRACTICE.

Malpractice (or malpraxis) may be defined to be bad or wrong practice—bad or wrong in its results, whether these be loss of limb by amputation, deformity, serious injury to health, or even death.

The responsibility of physicians has ever been a fruitful theme for discussion. It is comparatively rare that the subject becomes the source of a *criminal* prosecution, except in cases of feticide resulting in the death of the mother; but actions for damages before the civil courts, often for large amounts, are alarmingly frequent, and may well call upon the medical men to consider what their exact legal standing is in this matter, and what protection they are entitled to claim from the law, when thus assailed.

In the first place, it should be clearly understood that the physician or surgeon, when called to treat a case of disease or injury, does not become an insurer or guarantor to cure, any more than an attorney obligates himself to win the case for his client. In both instances, the professional man merely undertakes to do his best—"to bring to the exercise of his profession a reasonable, fair, and competent degree of skill." The medical man should always beware of compromising himself by a promise to cure his patient; if, however, he be so unwise as to have made such a contract, he will be held by the law strictly accountable for its performance. In case of failure, it will be no defense for

him to allege the occurrence of unforeseen contingencies,—these he was bound to have knowledge of. Neither may he allege a want of sufficient skill or dexterity; these he is supposed by the law to possess when he undertook the case. Thus, if a surgeon contracts to cure a patient of deformity by the removal of a limb, and death ensues through pyemia or erysipelas, he will be held liable for forfeiture of his contract. Or if he undertakes, by contract, to cure a woman of an abdominal tumor by the operation of ovariotomy, and death results through an unavoidable peritonitis, this will not excuse him. So, likewise, a lawyer contracting for the foreclosure of a mortgage will be held liable to his client, in case of failure on his part. In all these instances, the contract will bind the parties. Their fault and folly was to have undertaken what was beyond their capacity to perform.

In all ordinary cases, where there is no express stipulation between the parties, the medical man impliedly agrees to bring his best skill and endeavors to cure the patient. Formerly, the law made a distinction between a fatal issue following the treatment of the regular physician and that of the quack, regarding the former as only a "misadventure," but punishing the latter as manslaughter. At present, both in the United States and Great Britain, this distinction has been abandoned, the court regarding all systems of medicine as being entirely on a par, so that, if the practitioner announces himself, or herself, as belonging to any particular school or system of medicine, and practising as such, the patient who employs such a practitioner, and suffers thereby either in limb or life, has no legal redress; he has made his election, and must abide the consequences. Indeed, it would appear that the charlatan is, under the

present system of law, much more likely to escape in a suit for malpractice, than the most experienced regular physician.

It may not be always easy to determine just what "the ordinary degree of skill" used by law authorities means, since what might be regarded as an ordinary degree of skill in a large city, or centre of medical learning, would probably be considered by the untaught and inexperienced residents on the frontiers of civilization as very extraordinary skill, and *vice versâ*. Consequently, this term, "ordinary skill," must have a varied latitude of application, according to the circumstances of individual cases.

The following principles may be regarded as established, being founded on various judicial decisions, both in this country and in England:—

I. If the practitioner acted honestly, and used his best skill to cure, and it does not appear that he thrust himself in the place of a more competent person, it makes no difference whether he was, at the time, a regular or an irregular physician or surgeon. This principle has been stretched to its utmost limits, even where death has unquestionably resulted from the practice of notorious quacks, such as St. John Long and Samuel Thompson, although the grossest ignorance was proven against both of them. In the case in which an ignorant old man practising obstetrics, on one occasion mistook a prolapsed uterus for a placenta, and tore it away by main force, causing fatal hemorrhage, Lord Ellenborough, C. J., charged that "there was not a particle of evidence to convict the prisoner of the crime of murder." The prisoner was acquitted. This case illustrates, as Elwell justly remarks, how ignorant a Lord Chief Justice of England may be as to the science of medicine. He appeared to suppose that because an ignorant old man had the

temerity to act the part of an obstetrician among a class of ignorant women, that therefore he must necessarily have some skill—a most absurd proposition. "It no more inferred 'some degree of skill' in the prisoner, because he had delivered some women successfully before, than the fact that a woman who has delivered herself of ten or a dozen children, which is often the case, is evidence that she possesses some knowledge of the uterine system." Unquestionably, such a lack of anatomic knowledge as would cause a man to mistake a uterus for a placenta should be classed as the grossest ignorance, and should subject the pretender to severe punishment.

II. Not only ordinary skill, but ordinary care and attention to the patient are required of the attending practitioner. If a surgeon, for example, after skillfully performing an operation, neglects the after-treatment, such as proper dressing and bandaging, and, in consequence thereof, hemorrhage, pyemia, mortification, or deformity should result, he will be justly held responsible in an action for malpractice. In every such case, however, if the defendant can clearly prove these two points—an average amount of skill and competency, together with a proper degree of careful attention on his part—he may feel certain of an acquittal, unless the trial should happen to be before a stupid jury and a prejudiced judge.

III. As medical men are not infallible, the most skillful may err in judgment in advising a particular remedy, about which there is a difference of opinion. An error of judgment made by such a practitioner is clearly excusable. Lord Mansfield, speaking of attorneys, says: "Every man is liable to errors, and I should be very sorry to think that it should be taken for granted that an attorney is answerable

for every error or mistake, and to be punished for it by being charged with the debt he was employed to recover"; and Judge Porter remarks that the agent is not responsible "if the error was one into which a prudent man might have fallen. The contrary doctrine seems to suppose the possession, and requires the exercise of perfect wisdom. No man would undertake to render a service to another on such severe conditions."

If, however, an unusual and violent remedy has been administered by a person grossly ignorant of medicine, and this medicine has caused death, if the individual is of average mental capacity he should be held criminally responsible, since such a course would seem to imply malice on his part.

According to the civil law, when the practice of the attending physician or surgeon is called in question, the prosecution must show, first, that the injury to the health or body of the patient actually resulted from the bad treatment of the practitioner; and, secondly, that this evil result might certainly have been foreseen and avoided by a competent medical attendant. "Malpractice can only be affirmed when the practitioner has set aside established principles, and neglected to employ means which are universally held to be necessary in the given case." But before guilt can be established on any such derivation it must be shown (1) that the following out of the rules usually prescribed by medical science for the cure of disease never proves detrimental; (2) that there is at least the greatest probability that the observing of the rules would accomplish the desired end; and (3) that the great majority of medical men approve the rules.

IV. The almost universal adoption by modern surgeons

and gynecologists of antiseptic or aseptic methods in their practice might be likely to raise the question of malpractice in a case in which fatal results had followed an operation in which antisepsis had been neglected. The possibility of such a contingency should, we think, serve as a sufficient warning to the operator not to neglect such precautionary measures.

V. A medical man cannot be held guilty of criminal carelessness for failing to employ any particular remedy, since there is never any one remedy upon which all authorities are agreed ; and since it is always possible that the patient may recover without the use of such remedy. If it could be shown that there existed a specific remedy for any disease, then a neglect to use such remedy, on the part of the physician, would be criminal, and be punished as such. The uncertainty of remedies must necessarily allow a large latitude in their selection and employment ; and this uncertainty even affects, to some limited extent, the use of antidotes in cases of poisoning. But where it can be shown that a physician called to treat a case of poisoning failed to administer the universally accepted antidote, he should be held guilty of criminal carelessness, as, *e. g.*, albumin, in case of corrosive sublimate poisoning.

Casper goes further than this, and asserts that "a physician should be held liable to punishment if, in a given case, he departs entirely from the treatment which the great majority of physicians of his time adopt, and which the great majority of medical authorities recommend in such cases." But great difficulty would unavoidably result from adhering to such a rule ; it might often be impossible for the physician to stop to inquire, in any given case, what was the practice of the majority of his contemporaries.

Besides, this principle would render all homeopaths, eclectics, botanics, etc., liable to punishment.

In consequence of these doubts, the modern practice in the United States is that when a physician announces himself as practising under some particular system, as the homeopathic, eclectic, or botanic, and is employed by persons knowing that this is the case, he is, at least, not criminally responsible to them, in the event of serious results, because his views do not accord with those of what are called regular practitioners. While the law prescribes no one absolute system of medicine, a practitioner is expected to practice according to the system he professes and avows; a departure from this system, if accompanied with some serious or fatal mistake of remedy, would render him justly amenable to a criminal charge. Hence, a regular practitioner, and one employed as such, if he should surreptitiously, and without the patient's consent, use homeopathic or botanic treatment, to the detriment of his patient, would clearly be liable for damages to the latter; and, moreover, he could not recover his compensation for attendance, in a suit at law, because he had departed from his avowed system of practice. For the same reason a homeopathic or botanic physician, practising either of these systems avowedly, if he should have employed the regular system, instead of his own, and his patient failed to make a good recovery, would equally be held liable for damages, and would equally be exposed to a non-suit in an attempt to collect his fee, in a civil court.

The civil suits for alleged malpractice far outnumber the criminal actions. As already observed, the former are so alarmingly frequent as to occasion a general distrust, particularly among surgeons. A large number of such suits

are brought evidently for the purpose of blackmail—plaintiff being usually in league with some lawyer, with whom he has agreed to share the fees ; and he resorts to this practice as a convenient mode of discharging his doctor's bill. Generally speaking, the discrimination of the court is adequate to detect and expose the fraud, even to a jury, which is often too ready to side with the plaintiff in a trial of this nature.

It is a question whether a slight deviation from the ordinary modes of performing operations should involve a charge of malpraxis. Taylor refers to a remarkable case occurring in this country, in which an action was brought and damages recovered against a physician for alleged negligence in vaccinating a young woman. Some inflammation followed the operation, which, it was asserted, was performed nearer the elbow joint than usual. The judge, singularly enough, ruled that "the physician is liable for all the bad consequences resulting from vaccination or inoculation, if he fails to insert the virus in that part of the arm usually selected for the purpose, notwithstanding many other parts of the body might be proved to be equally proper and even more suitable locations!" Taylor calls this "a very singular specimen of transatlantic jurisprudence."

Gratuitous service on the part of the practitioner will not exempt him from an action for malpractice, if either ignorance or carelessness in his attendance can be proven against him.

A patient who refuses to coöperate with his medical attendant, and who thereby sustains injury, cannot recover compensation for the injury, unless the latter is clearly traceable to the attendant's malpractice.

It has lately been decided that when a physician took with him, without necessity, to a case of confinement, a young unmarried man not a physician nor student of medicine, and the fact of his not being a medical man was unknown to the patient or her husband, both the physician and the attendant were liable for damages.

There is another source of liability to an action for malpractice, which is not generally alluded to, but which from its gravity certainly deserves notice—viz., inebriety. Most assuredly, if a physician or a surgeon, when inebriated, undertakes to prescribe for a patient, or to operate upon him, he places the latter in serious and possibly fatal jeopardy; and for this he should undoubtedly be held responsible. Many States have enacted statutory laws upon this subject. These laws vary somewhat in the severity of the punishment annexed to the offense.

It is worth while noting that it has been decided by one of the courts that to enable a physician to recover, by suit, fees for services, the record of such services must be kept in an intelligent form and in a regular book. Cabalistic signs indicating visits, office consultations, etc., are not evidence.

The liability of druggists rests practically upon the same principles that govern physicians. Ignorance and carelessness in putting up prescriptions, whereby gross or even fatal mistakes may occur, should justly render them liable to an action at law. So, likewise, the entrusting the compounding or vending of medicines to careless clerks or inexperienced apprentices would entail criminal responsibility upon the principal.

There is a special law in some States in relation to the

selling of poisons by the apothecary without a physician's prescription; and also regarding the proper labeling of the same before sending them away.

One authority states: "Druggists, like physicians, come under the laws governing specialists. They are bound to know—expected to know—the kinds and natures of the medicines with which they deal. . . . If an apothecary administers improper medicines, the law holds him liable, although his contract is with a third person."

Another authority says: "A druggist deals in things certain—things which his eyes can see and his hands can handle. He, like the physician, is liable for ordinary care and skill; and it is only ordinary for a druggist to know of every medicine in his shop and to have his medicines in their proper places and properly labeled."

A few States have legislated in relation to the mistakes made by druggists and their clerks in the compounding of prescriptions, the penalties affixed being regulated by the amount of damage done; if death resulted, it is regarded as a felony and punished by a heavy fine and imprisonment. Doubtless, however, the punishment would be much milder, provided the culprit could prove a previous good character as to "competency and skill," and that he has come fully up to what the law terms "a duly qualified assistant." In the latter case, his mistake, even though attended with fatal consequences, would probably not be regarded legally as "culpable negligence," but would rather come under the head of "excusable homicide," or "homicide by misadventure," where there was no evil intention on the part of the perpetrator, but where the mistake was made "under circumstances of sudden confusion, which threw him off his guard."

The means of diagnosis in certain classes of cases have been so materially increased by the introduction of X-ray methods that it is obvious that charges of malpractice may now be easily sustained in cases in which in former years no such liability would have been incurred. It is as yet uncertain, however, how far the courts will hold the application of these methods to be necessary, or admit the evidence that is thereby obtained. It is also obvious that the various tests for diagnostic purposes will, in time, be an important factor in questions of malpractice, but nothing definite can be given at present.

CHAPTER XV.

LIFE INSURANCE.

Insurance on a Life is simply a contract whereby the company that insures, in consideration of a certain sum, payable in instalments and denominated a premium, agrees to pay a stipulated amount at his death to his heirs or a designated person, or to the insured himself at some definite period of his life. The deed by which this contract is made is termed a policy. This policy contains a great number of provisions and conditions, and it is upon the proper construction of these that legal disputes frequently arise.

The amount of premium to be paid depends chiefly upon the age of the applicant, though also somewhat upon the sex and occupation.

The amount insured for (if payable at death) cannot be recovered until distinct and satisfactory proof of death be furnished by the beneficiary of the policy. Upon this proof the companies insist with great positiveness, inasmuch as fraudulent insurances are so frequently effected and the companies are thereby victimized.

In case of mysterious disappearance of the insured, with no clew to his whereabouts, the law allows an interval of seven years to elapse (presumption of death) before payment can be pressed; but it is usual for the company to make the payment much before this period, unless there is good reason to suspect fraud. This is especially true of

persons going to sea, where the presumption of death may be settled sooner. Again, the question of survivorship may be raised, as when two or more persons perish by the same calamity—as by shipwreck—and one happens to be insured for the benefit of the other.

Among the conditions of a policy, the most important one is the general health of the applicant, as influencing his expectation of life; and it is just here that medical science is always appealed to to decide upon the actual condition and the proclivities to disease through hereditary or other causes. The printed questions in the policy are both numerous and pointed, and they should be answered truthfully, since the contract is equally binding upon the insured as upon the company; and if it be subsequently discovered that any fraud has been perpetrated through misrepresentation or concealment of facts in relation to disease or bad habits, the policy will be voidable and the premiums already paid forfeited. This is just and equitable; and no respectable company refuses to pay the amount of a policy, unless there is a reasonable ground to suspect a willful fraud in the contract.

Still, lawsuits occur very frequently in regard to life insurance, and the contested points usually have reference to the significance of medical terms or phrases in the contract, such as "any other diseases or habits tending to shorten life," etc. It is surprising how often the applicants will prevaricate and dissimulate upon these last-named points, and especially upon their habits as regards the use of alcoholic drinks. Medical examiners for life insurance companies find it difficult to get clear and satisfactory answers in relation to the habits of the individual as regards the use of alcoholic beverages. Often will it be found that the

man who is in the habit of taking three or four drinks of spirits daily will consider himself a perfectly temperate man ; and, unless he is closely questioned and made to give distinct replies, he may be classed in the policy as strictly temperate, when all the while his health is undoubtedly being undermined and his expectation of life thereby shortened, although he cannot properly be classed as an inebriate.

The suppression of a fact in relation to the health of the applicant, if not known by him, will not invalidate his policy. This was determined in a case in which Dr. Reese was an expert witness, decided on appeal to the United States Supreme Court in 1880. Here, the main defense was that some of the answers to the interrogatories of the policy were not true, but that the insured was, at that time, actually suffering from certain alleged diseases mentioned in the contract. There was only one witness to support this allegation, a homeopathic physician, who had prescribed for the plaintiff thirteen years before "for chronic asthma, manifestations of the first stages of consumption, and scrofula." This witness, as it appears, never mentioned his suspicions to his patient, neither did he testify positively that the patient really had the diseases for which he treated him ; and, moreover, the testimony of the insured was that "he never learned from him, nor from any other physician, nor had he ever suspected, nor had the remotest idea, that he was affected with any such diseases ; but, on the contrary, he always boasted of himself as being a strong, healthy, and robust man." Clearly, in such a case, the applicant should not be held responsible for the suppression of a fact of which he was utterly ignorant and of the very existence of which there was considerable doubt.

In all cases the exact state of the applicant's bodily health should be ascertained, either by his answers to the written categorical questions, or by oral questioning by the medical examiner. The case of the Duke of Saxe Gotha is cited as an illustration of the importance of not concealing material facts. The applicant, while residing abroad, was insured in an English office for the sum of £3,000. The certificates of his two German medical examiners stated that his general health was good, although he had an impediment in his speech and an affection in one eye, but that he was perfectly free from disease or symptoms of disease. The facts were that the Duke had been suffering from cerebral disorders for over two years, that he was childish and could not speak. He died of paralysis within nine months afterward, and an autopsy disclosed a large tumor, evidently of long standing, pressing upon the brain together with an effusion of ten ounces of serum. The plaintiff was non-suited.

The question of intemperance in relation to the habits of the insured causes, probably, more discussion and difference of opinion in contested life-insurance cases than any other. It would seem almost impossible in such cases to define what intemperance is. An instance is mentioned by Taylor which illustrates the difficulty of getting at the truth. In this, payment was refused on the ground of concealed habits of intemperance. Twelve witnesses were called by the plaintiff to prove that the deceased was a very temperate man, while the office called twenty-one to show that he was habitually intemperate. The medical man who furnished the certificate stated that he considered it a perfectly safe risk ; for, although he had occasional outbreaks, he did not think drinking had any bad effects upon his health. This

case shows the differing views entertained by even medical men upon this subject.

While we must admit that there are a few exceptional cases of persons who are habitual moderate drinkers living to old age, and enjoying apparent uninterrupted health, we cannot be blind to the fact that habitual drinking does certainly and gradually impair the health, inducing dropsy and organic disease of the stomach, liver, and kidneys, which unquestionably tend to shorten life.

If a true representation of the temperate habits of the insured was made at the time of application, and he should subsequently fall into habits of intemperance, this would be no bar to a recovery upon the policy. In many of the modern policies the proviso against intemperance is omitted.

The above general principles will serve also as a guide in cases of the opium or chloral habit. A concealment of the fact that the applicant was addicted to opium eating, even although it might be alleged that this habit had not impaired his health, would undoubtedly be an obstacle to a recovery upon the policy.

As regards the question whether insanity has a tendency to shorten life, and therefore whether the concealment of its existence in the applicant amounts to the concealment of a material fact, it may be said the almost uniform experience of physicians is that it does tend to shorten life. Moreover, there is in nearly every policy a direct question bearing upon this point, the company reserving to itself the right to reject the particular applicant thus affected.

The relationship of suicide to life insurance is one of considerable interest, and has been the source of frequent litigations. The principle by which any particular case is to be decided is—Was the suicide evidently the result of in-

sanity, and did this insanity come on after the policy was taken out? If so, then clearly the insured is entitled to recover, just as much so as if the suicide was caused by the acute delirium of a fever, or by inflammation of the brain. But if it can be shown that the suicide was the result of a deliberately formed purpose, with a motive sufficiently strong to impel to the act (such as to get rid of impending debts, or to bestow the insurance money upon the individual's family), then there was no insanity connected with the act, and the policy should be void, because the insured had voluntarily shortened his life. In a doubtful case of this character, the turning-point would seem to be to determine if the suicide could be traced to a perfectly intelligent motive. For example: It is credible that an individual pressed down by the burden of some enormous debt, which he has been vainly hoping to pay, and with the poverty and degradation of his family staring him in the face, should embrace a tempting offer to insure his life for an amount that will not only repay his indebtedness and rescue his name from dishonor, but at the same time save from poverty and want those whom he loves better than himself. Why should not the spirit of self-sacrifice be as dominant in such a one as in the embezzler who, to avoid the discovery of his frauds and the disgrace and punishment consequent thereupon, voluntarily takes his own life. A very suspicious circumstance in connection with these cases of suicide and life insurance is the fact that the deceased has rarely made more than one or two payments on his premium before committing the suicidal act.

One of the most remarkable cases of this character, in which the question of suicide by strangulation was urged

by the defense, is that of Col. Dwight, which was tried in Norwich, N. Y., in December, 1883. This gentleman had been involved in heavy pecuniary difficulties, through extensive financial operations. A few months before his death he effected insurances on his life to the amount of three hundred thousand dollars, on which he had made one quarter's payment before he died. He had been complaining some weeks before of chills, loss of appetite, and sleeplessness ; but on the day of his death he was comfortable, was up and dressed, saw company, and executed legal papers. About half-past eleven o'clock on that night he was heard to gasp for breath by his attendant, who was in an adjoining room ; he immediately went to his aid, raising him up, and then summoned his wife and other friends ; death occurred almost immediately afterward. The question to determine was whether deceased had strangled himself with a cord, or whether the death had resulted from an overdose of morphin, of which he had taken about three grains throughout that day by the advice of his physician. To support the theory of suicide by strangulation, several highly respectable physicians testified to the presence of one or more distinct depressions around the neck, having all the characters attendant on the usual marks of a constricting cord. These marks were attempted to be explained away by attributing them to the folds of the skin of the neck due to the bending of the neck in the ice-box. But they were also noticed several months later, on the exhumation of the body. On the side of the plaintiff, it was alleged that the death was due to heart exhaustion, precipitated by the overdose of morphin. No testimony, singular to say, was taken from the persons who were wit-

nesses of the death, save the one who sat up with him, and this man said nothing about strangulation, but gave the idea of its being a natural death. The jury found for the plaintiff, thus ignoring the idea of a fraudulent suicide. The insurance companies appealed, and after trials in several courts the case was compromised.

A decision has recently been made by the United States Supreme Court declaring that when a person of sound mind commits suicide the life insurance becomes void.

CHAPTER XVI.

TOXICOLOGY.

Poisoning is probably the most frequent of all the causes of violent death, the casualties of war excepted. The facility with which poisons may be procured, the ease with which they can be administered, and the close resemblance that the effects of many of them bear to disease in symptoms and post-mortem lesions, will account for the fact of their extensive employment, both for homicidal and suicidal purposes.

A Poison is a substance which, when introduced into the body by any method, occasions disease or death ; and this as an ordinary result, in a state of health, and not by a mechanical action. It must be as an ordinary result : a substance, for example, which affects one person injuriously through idiosyncrasy, is not to be called a poison. Again, it must be in the healthy system : as is well known, many diseases render the system extremely susceptible to impressions by external agents ; *e. g.*, in gastritis, the blandest substance—even water—may excite vomiting. Again, the substance must not act mechanically : thus, powdered glass, fragments of iron, etc., may produce death when swallowed, through direct mechanical irritation ; yet these cannot be regarded as poisons.

According to the above definition, it matters not by what avenue a poison gains access into the body, its ultimate

effects are the same. The stomach, of course, is the most usual means; but the rectum, the skin, the lungs, and the cellular tissue by hypodermic injection, and even the nose, ear, and vagina, are also channels of entrance. Inhalation of poisonous vapors through the lungs, and the subcutaneous introduction by the hypodermic syringe affect the system far more rapidly than by swallowing, because of their more rapid absorption.

The mere size of the dose constitutes no distinction, legally, between a poisonous and a non-poisonous substance; thus, half a grain of strychnin, or half an ounce of oxalic acid, may be the quantity which proves fatal.

The Effects of Poisons are local and remote. The local effects are the direct impressions produced on the part of the body with which the poison comes into contact—*e. g.*, the corrosion of the stomach and bowels by the immediate contact of the mineral acids and alkalies. Often a poison may act both locally, by its causing inflammation of the stomach, and also remotely, on the brain and nervous system.

The remote effects of a poison are those results which are produced on parts of the system remote from that to which it was first applied, as, *e. g.*, the narcotic effects of opium on the brain, after being taken into the stomach. These remote effects constitute, in fact, the usual symptoms of poisoning—a very important factor in the diagnosis of the case.

Mode of Action of Poisons.—In order that a poison should produce its full effects on the system, it is necessary that it should get into the circulation, so as to be conveyed

to distant parts of the body; and for this purpose it must first be absorbed. Although other modes of transfer of the poisonous impression to remote parts of the system have been at various times recognized,—such as nervous communication and contiguity of structure,—the present accepted doctrine is that of absorption into the circulation. The so-called corrosives produce local actions that are generally sufficient to produce death.

The proofs of absorption are abundantly afforded (1) by the detection of the known poisons in the blood; (2) in the secretions, especially the urine; and (3) in the different viscera of the body, as the liver, kidneys, lungs, spleen, brain, etc. An essential part of the toxicological examination is to discover the poison, in the absorbed state, in the viscera.

The rapidity of the absorption is remarkable. It has been shown that a poison injected hypodermically will be diffused through the circulation in a few seconds. A solution of hydrogen sulphid injected into the rectum of a dog was eliminated by the lungs in sixty-five seconds.

The rapidity of absorption is materially influenced (1) by the solubility of the poison; so long as the substance is insoluble it cannot be absorbed, but many substances insoluble in water speedily dissolve in the fluids of the stomach and intestines, and so pass into the circulation. (2) By the nature of the surface to which it is applied, it being in direct ratio to the vascularity of the part. It is for this reason that the most rapid absorption is from the air-cells of the lungs, when the substance is inhaled in the form of vapor, and is immediately taken up by the very extended vascular pulmonary area. For this same reason, also, when it is injected directly into the blood vessels, the effect is

almost instantaneous. Christison injected conin hydrochlorid into the femoral vein of a dog, and death took place in three or four seconds. Some animal poisons, such as the virus of glanders, syphilis, smallpox, etc., when swallowed, appear to undergo a change, through digestion, which renders them innocuous. The absorption of poisons in the stomach is modified by the condition of that organ—being most rapid when it is empty. The skin may be the avenue for the introduction of poisons, as witnessed in the absorption of arsenic, tartar emetic, corrosive sublimate, opium, etc., when applied in ointment or washes. By removing the cuticle, the absorption is much more rapid, as seen in the endermic method. (3) Fullness of the blood vessels. The rapidity of absorption is inversely to the quantity of the circulating fluid; hence, depletion by bleeding or purging will favor absorption.

But admitting the fact of absorption, the further question whether the fatal effects of the poison are to be ascribed to this, is answered affirmatively by showing that these effects continue so long as the circulation of the blood goes on between the point of insertion and the organs affected, and that they cease when the circulation is arrested. The oft-quoted experiment of Magendie establishes the first of these propositions. He divided all the tissues of a frog's leg except the blood vessels, and inserted the foot into a solution of nux vomica; absorption took place through the blood and fatal tetanic convulsions ensued. The same experiment repeated on a leg in which the blood vessels only were divided (they interrupting the circulation), produced no effect upon the animal. The second proposition is proved both by the foregoing experiment, and in the following: Hydrogen cyanid was introduced into the stomach

of a dog, through an opening in its walls. So long as the vessels passing from the stomach to the liver were secured by a ligature, no poisonous effects were produced; but they were manifested within one minute of the removal of the ligature.

Subsequent Disposition of the Poison.—After absorption into the blood, as the poison passes through the different organs, a portion of it is immediately separated by these, and at once eliminated by the various secretions, bile, urine, saliva, pancreatic fluid, and sweat. Another portion may be temporarily deposited in the organs and tissues, and usually in the following order as to quantity: the liver, spleen, kidneys, heart, lungs, brain, pancreas, muscles, and bones. To this order there may be occasional exceptions, as some recent experiments seem to prove that lead and certain other mineral poisons show an especial affinity for the spinal cord and brain. Only a minute quantity of the poison is circulating in the capillaries at any one time, yet there is good reason to believe that it is exclusively this small portion which is really noxious; while still remaining in the stomach, or retained in the organs, it is harmless. Hence, it is a common mistake to attribute death to the actual quantity of the poison found in the stomach of the deceased: this is only the surplus, or complement, of what was necessary to kill. It has, in fact, no direct connection with the fatal result, this being caused by the absorbed portion only (except in the case of the corrosives, which act locally). Although that portion of the poison which is retained in the organs (absorbed) is, for the time being, innocuous, yet, as it is liable to be reabsorbed into the circulation, it may again prove active. Hence, in the treatment of

a case of poisoning, the importance of completely eliminating the noxious agent from the system.

While we have no positive proof that all poisons are deposited in the organs, we know that this is true of the mineral, and of many of the vegetable poisons. The gaseous poisons appear to be eliminated by the lungs immediately, without this deposition. This was proven by Bernard, who injected into the jugular vein of a dog a cubic inch of water saturated with sulphuretted hydrogen. A piece of paper, wetted with solution of lead acetate, was held to the dog's mouth. It blackened in from three to five seconds, showing that the gas had been eliminated from the lungs. This elimination was completed in a few seconds.

The time required for an absorbed poison to be removed from the circulation, either by elimination or by deposition in the organs or tissues, varies for different substances, and also, probably, for different conditions of the system. Certain medicinal substances are known to appear in the urine a few minutes after being swallowed—*e. g.*, potassium iodid and turpentine. In relation to mineral poisons, there is reason to believe that they are rapidly separated from the blood. Experiments have shown that arsenic may be diffused throughout the body of an animal in an hour and a half after being swallowed. It has also been found in the urine of a horse within one hour after administration. Taylor found arsenic in the human liver four hours after being swallowed. Doubtless it reaches this organ much sooner than this, although no opportunity has as yet been afforded of proving the fact, since death rarely occurs earlier than the above period. Taylor believes that the liver acquires its maximum of saturation by arsenic in fifteen hours after the ingestion of the poison. He gives a table

of the estimated average amount of this poison that will be found in this organ at different periods: In five to seven hours after taking, the quantity is 0.8 grain; in nine hours, 1.2 grain; in fifteen hours, 2.0 grains; in seventeen to twenty hours, 1.3 grain; in fourteen days, 0.17 grain. It is generally admitted that arsenic is entirely eliminated from the human system in about fifteen days, but cases have been reported where the poison was detected in the urine as late as the twenty-fifth day. As a rule, the analyst need hardly expect to find any traces of arsenic in the body of a person who has survived fifteen days after swallowing it.

Other mineral poisons require a longer time for their elimination from the human body. According to Orfila, arsenic and corrosive sublimate require thirty days; antimony, four months; silver, five months; lead and copper, over eight months.

This doctrine of the elimination of poisons must be held with some reserve. The question may at times assume very serious importance. Suppose a case of alleged arsenical poisoning, in which the deceased had survived two or three days, but in which the toxicologic examination failed to reveal any traces of the poison in the liver or other viscera. Here, the defense might very plausibly urge that the death was not caused by the poison, as alleged, inasmuch as it could not be found in the viscera, where it ought to be discovered (according to authorities), if life was not protracted beyond fifteen days. There must be exceptions to the above rule, as in a case in which there had been excessive vomiting and purging from the first, and the dose of the poison comparatively moderate. Taylor mentions a case of this nature, in which arsenic had caused death in twenty-six hours; there had been much vomiting and purg-

ing, and, on examination, the poison had nearly disappeared from those viscera in which it is usually found. In such a case, if the other evidences of poisoning were present, the negative chemical testimony is of less moment. On the other hand, a case may present itself (as it has to the author) in which a person who has been taking small doses of arsenic, medicinally, for a length of time, dies suddenly, with gastro-enteric symptoms and under suspicious circumstances. Here, an examination of the liver may discover traces of arsenic, and this may be regarded by the prosecution as proof of criminal administration, especially if it could be shown that the deceased had not taken the medicine for at least fifteen (thirty) days before death. In such a case, in the absence of all the other factors of evidence, the finding of traces of arsenic in the liver, within the period of time above mentioned, would not establish it as the cause of death.

The Mode of Death by poisons has been a subject of much discussion. It must be admitted that we are not in possession of the full knowledge of this subject. We know that the various poisons circulate through the blood, and thus come in contact with some one of the great centers of life—the heart, the lungs, and the brain and spinal cord—and then and there produce their specific effects; one, on the brain, causing narcotism; another, on the heart, producing asthenia; a third, acting on the spinal cord, causing tetanus, etc.; but why they possess this elective affinity for these different organs we are unable to explain. Neither do we understand why different poisons exhibit a similar election in their modes of elimination from the system, *e. g.*, potassium iodid passing out, by preference, through the

urine; mercury, by the saliva; arsenic, by the glands of the stomach, etc.

One mode in which death occurs by poisoning is probably by shock on the general nervous system, as seen in the case of the powerful corrosives—their violent local action causing a general depression of the system very similar to that occasioned by a severe superficial burn or other severe injury. Most probably there is some histological or pathological change produced by the poison in the organ or tissue.

The fact that poisons must enter the circulation before they can become effective naturally suggests the idea of some chemical or other change produced on the blood, and possibly on the poison itself. This, however, cannot be proved. As regards any physical alteration of the blood corpuscles, microscopic examination has failed as yet to discover anything that can be regarded as conclusive, although it has demonstrated alteration in their size, shape, and color, in the case of certain poisons.

Modifying Circumstances connected with Poisons.—Some of these relate to the poison itself, and others are connected with the system. Among the former, the dose and mode of administration require notice. As a rule, the larger the dose, the more speedy the action. An exception to this is seen in the case of some irritants, such as arsenic, where a large dose may be rejected by vomiting, and might thus prove innocuous, while a smaller one would be retained. The effect of some poisons is much modified by the dose; thus, a large dose of oxalic acid kills almost immediately by shock, while a smaller one will act upon the heart and nervous centres, and prove fatal more slowly.

The effect of combinations of poisons is sometimes to increase, sometimes to diminish, their activity, and, again, to antagonize or neutralize their action. According to Christison, the effects of arsenic are decidedly modified by alcoholic intoxication, which seems in some way to arrest, or suspend, its action. This is also probably true of other irritant poisons. The same authority mentions a case where a very large dose of corrosive sublimate and laudanum was taken, and there was a remarkable postponement of all the usual symptoms.

Antagonism of Poisons.—That an antagonism exists between certain poisons—the one neutralizing the effects of the other in the animal system—has been satisfactorily demonstrated. Experiments on frogs go to prove that this antagonism is of a twofold character—physiological and toxic. For example, calcium salts given in toxic doses occasion complete ventricular contraction in the frog's heart, the animal dying with the heart in systole. On the other hand, potassium salts produce relaxation of the ventricle, and death occurs in diastole. But by a careful equipoise in the dose of these two salts the physiological effects of each can be mutually and completely controlled and neutralized by the other, so that the normal action of the heart is restored, and the animal survives. A similar antagonism has been found to exist between veratrin and potassium salts—the alkaloid here acting precisely like a calcium salt in neutralizing the effects of the potassium salt.

Hence we may regard the action of antidotes, in cases of poisoning, as being of a twofold character—physiological and chemical.

This question of antagonism acquires much greater in-

terest and importance when we come to consider its bearing in certain cases of criminal poisoning, in which, in the absence of the usual chemical and other recognized proofs of the alleged poison, the attempt is made to show that by a combination of poisons their action upon the human system will become so modified as to conceal the symptoms, and prevent their discovery after death by the usual chemical tests. It then assumes a considerable importance. This doctrine was—for the first time, apparently, in this country—urged with some plausibility, at the celebrated trial of Dr. Paul Schœppe, at Carlisle, Pa., in 1869. After the failure by the prosecution to establish the allegation of poisoning by hydrogen cyanid (inasmuch as the single symptoms were rather those of apoplexy), it set up the claim that the death was produced by a mixture of hydrogen cyanid and morphin, and ascribed the absence of all the usual symptoms of the former, and the failure to detect either it (except by the merest trace, which was shown might result from the faulty method of the analysis) or the morphin, to the alleged antagonism of the two substances, although there was not the slightest evidence of the administration of either. In the year 1870 Dr. Reese made a number of experiments upon dogs, with a view of determining this question. A few of the results will be briefly detailed here :—

(1) *Morphin and Hydrogen Cyanid.*—If both poisons are given in full lethal doses, the symptoms of both toxic agents are exhibited. The morphin never counteracts the fatal effects of the other body, if the latter be taken in full poisonous doses.

(2) *Morphin and Atropin.*—The mutually antagonizing influence of these two alkaloids is now fully recognized in the human subject ; but it is less manifest in dogs.

(3) *Strychnin and Hydrogen Cyanid.*—These powerful poisons evince no real antagonism. When both were taken in full doses, the usual symptoms of each were exhibited alternately—convulsions and tetanic spasms.

(4) *Strychnin and Morphin.*—These alkaloids show no disposition to antagonism when given in full doses. The narcotism of the morphin (taken first) was speedily followed by the tetanus of the strychnin (taken afterward).

(5) *Atropin and Escrin.*—The investigations of Dr. Frazer with these substances on dogs demonstrate a real antagonism, which was confirmed by Dr. Reese's experiments.

(6) *Atropin and Strychnin.*—There would seem to be a true antagonism between these two alkaloids, sufficient to justify a resort to the use of atropin in a case of strychnin-poisoning.

There also appears good reason for admitting the antagonism between *Aconite and Digitalis*—sufficiently so to warrant a trial of digitalis in a case of poisoning by aconite.

The conditions of the system that modify the action of poisons are habit, idiosyncrasy, and disease. Habit usually diminishes the power of poisons, as shown especially in the case of the narcotics, opium and alcohol. It is also alleged to be true in the case of arsenic, as seen in the arsenic-eaters of Styria and other mountainous countries.

The effect of disease in modifying the action of poisons is witnessed in the tolerance by the system of opium in tetanus and mania-a-potu, and of its increased susceptibility to this drug in apoplexy and inflammation of the brain. In paralysis, the susceptibility to the action of strychnin is diminished.

The influence of sleep is usually to diminish or retard

the action of poisons. This is true of arsenic and the irritants generally. The narcotism produced by opium seems to produce a similar effect, and also to mask the symptoms.

A knowledge of the **Evidences** of poisoning constitutes an important point to the toxicologist. These evidences comprise (1) those derived from the *Symptoms;* (2) those obtained from the *Post-mortem appearances;* (3) those afforded by *Chemical analysis;* (4) those derived from *Experiments on animals;* (5) the *Moral or Circumstantial evidences.*

I. Evidences afforded by Symptoms.—These constitute a very important factor in the diagnosis of poisoning, but, alone, they can never be sufficient to establish the fact, although they often furnish a very strong presumption. There are no characteristic symptoms of any poison; if this were the case there would be no need of ever making a chemical examination, since the symptoms alone would be sufficient to decide the case. To this there may be an exception in poisoning by the strong mineral acids and alkalies, the local action of which is so apparent.

The first point to notice is the sudden occurrence of violent symptoms in a perfectly healthy person, soon after taking food or drink. Most poisons produce their effects very soon after their administration—some of them almost immediately. But if given in very small quantities, and at intervals, as in slow poisoning, the symptoms may come on gradually, and be readily mistaken for disease. The physician should be extremely cautious about mentioning suspicions of poisoning in a case of this character before he has thoroughly investigated the case.

The suspicion is strengthened if several persons, after partaking of the same food, are suddenly seized with the same severe symptoms. But even here it might happen that some disease, like cholera, may have simultaneously attacked several persons after partaking of a meal. Taylor mentions an instance of this character, occurring in London, where three out of four members of a family, under suspicious circumstances, were suddenly seized with violent symptoms that were strongly indicative of irritant poisoning, but which proved to be malignant cholera, which was prevailing at that time.

A third feature connected with the symptoms is their rapid course toward a fatal termination. This, however, is not of much practical value, since the most active poisons do not always prove fatal immediately, while, on the other hand, many diseases run their course very rapidly.

From what has just been said about symptoms it will be readily understood that the practical difficulty consists in distinguishing between these and the symptoms of disease. We shall, therefore, briefly consider those diseases whose symptoms most resemble the symptoms accompanying poisoning. The disorders which most simulate irritant poisons are cholera morbus, malignant cholera, gastro-enteritis, peritonitis, ulceration of the stomach, ileus, and hernia. Those which most resemble narcotic poisoning are apoplexy, epilepsy, inflammation of the brain, tetanus, and certain cardiac diseases.

Cholera morbus strongly resembles arsenic poisoning, and is frequently mistaken for it. Two cases of this character were reported, in which death occurred in about eight hours, both of which were mistaken for cholera morbus by the attending physician, and were so certified before the

Board of Health; but both of which, however, yielded, by analysis, the most positive evidence of arsenical poisoning.

Malignant cholera most resembles the action of tartar emetic in its symptoms, such as the excessive nausea and vomiting, the rice-water dejections, the cramps, the extreme weakness, etc. *Gastro-enteritis*, *peritonitis*, *ulceration of the stomach*, *ileus*, *and hernia* all present symptoms which strongly resemble many of those witnessed from irritant poisons.

Many of the features of *apoplexy* bear a striking resemblance to the symptoms of opium poisoning; whilst *epilepsy* in some of its symptoms resembles poisoning from hydrogen cyanid; and the effects of strychnin bear a strong likeness to those of *tetanus*.

A knowledge of the above facts should put the practitioner upon his guard against too hastily deciding on a case of poisoning from the symptoms alone; and, on the other hand, he should not be misled in attributing to a supposed disease what is really the result of a poison.

II. Evidences obtained from Post-mortem Examination.—The rules governing an autopsy in a case of poisoning are the same as those which regulate other post-mortem examinations. One important rule should always be observed, namely, that the examination should be thorough and exhaustive, so as to overlook no lesion and no cause of either accidental or natural death. The rules already given for conducting a post-mortem investigation need not be repeated here.

The importance of receiving the stomach and other viscera into a perfectly clean jar may be inferred from the fact that the showing that this vessel was not clean, at the

trial, would be sufficient to destroy all the chemical testimony. This is well illustrated by a case in the experience of Robert Bridges. The viscera had been carelessly placed in a tin can that had contained zinc paint. The analyst discovered zinc in the viscera, for which he was at a loss to account until the above fact was ascertained.

In the examination of the stomach it is recommended to open this organ along the lesser curvature, and, after carefully collecting and measuring the contents, to spread it out upon a clean pane of glass or large flat dish, with the mucous surface outward; it should then be carefully inspected, with the aid of a magnifier, and any abnormal appearance noted, together with any foreign substance, such as crystals of arsenic, fragments of phosphorus, suspicious powders, pieces of vegetable matter, etc. These should afterward be examined with the microscope.

The evidences furnished by the post-mortem, like those derived from the symptoms, can never be absolutely conclusive, but only strongly suggestive; for many diseases exhibit precisely the same post-mortem lesions. Sometimes the external inspection of the body may throw some light on the case, as when certain stains of the mineral acids are discovered about the mouth, cheeks, tongue, and fauces, and also on the dress of the person. Occasionally the odor of hydrogen cyanid, opium, alcohol, nicotin, or phosphorus may be perceived on the corpse. On opening the body, the odor of such substances, if present, is usually more decided; and in phosphorus-poisoning the white fumes, which are luminous in the dark, as well as the garlic-like odor, are often very perceptible. Again, the remnants of certain poisons may be at times discovered in the stomach and bowels, such as cantharides, Scheele's

green, nux vomica, arsenous oxid, and orpiment; also vegetable leaves and fibres, which latter may be recognized by their structure. The aid of the microscope may here be required.

As regards the true pathological lesions resulting from poisoning, it may be remarked that, as a rule, the irritant poisons leave behind them decided marks of congestion and inflammation of the mucous membrane of the stomach and bowels, together, at times, with ulceration, perforation, and gangrene; while the neurotics leave their impress upon the brain and spinal cord, in the form of congestion, inflammation and effusion in these organs, and sometimes congestion of the lungs. The negative evidence, in the absence of all marks of irritation of the stomach and bowels, against irritant poisoning, although strong, is not absolute, because, in exceptional cases, death from these powerful irritants may occur without leaving behind any pathological lesion.

Among the most common of the post-mortem signs produced by irritant poisons is redness; this, however, is a constant symptom attendant on many disorders; and it occurs simply as a post-mortem change. A similar congestion is also witnessed in some cases of death by suffocation, strangling, hanging, and drowning. The examiner should hence beware of attaching too much importance to this sign exclusively. On the other hand, it is equally misleading and unscientific to exclude poisoning as the cause of death simply on account of the absence of any apparent pathological change in the lining membrane of the stomach; since many cases are recorded of death from large doses of arsenic which left no traces whatever of its irritant action on that organ. Ulceration is occasionally the result of irritant poisoning. It is, however, much more frequently the

sequence of disease; and, as this latter is apt to be insidious and generally unsuspected until a sudden fatal termination, it might readily be mistaken for a case of poisoning. Softening of the mucous lining of the stomach and bowels may result from both poisoning and disease; it cannot, therefore, be accepted as a proof of the former. Perforation may occur from the action of a corrosive, as the mineral acids and alkalies, and also from disease; but in the latter case the aperture is small, while in the former it is large and ragged, and its edges are soft and friable; moreover, the poison escapes into the abdomen, and can there readily be detected.

III. Evidences from Chemical Analysis.—The actual discovery of the poison by means of chemical analysis is usually regarded as the most satisfactory and positive evidence of poisoning; and it is a prevalent notion that the case cannot be made out, without the production of the poison, as the *corpus delicti.* This is, however, an error. The law requires the satisfactory proof of death by poisoning. The question is, Can satisfactory proof be afforded without the chemical detection of the poison? The reply to this inquiry is that it undoubtedly can, in certain cases. Many convictions have occurred in trials for poisoning, without this particular line of proof. If it were always deemed absolutely essential, doubtless many criminals would escape. It is well understood that for certain poisons there is no known characteristic test; besides, circumstances may interfere to prevent a proper examination. If, however, the other branches of evidence fail, and if, at the same time, the analytic proofs are unsatisfactory, then the case must be abandoned.

On the other hand, supposing the analysis reveals the presence of poison in the stomach, this does not necessarily prove that the death resulted from poisoning. Indeed, in the absence of the usual symptoms, the pathological lesions, and other proofs, it might plausibly justify the suspicion that the poison had been secretly introduced into the body after death, for sinister purposes, or without evil intention, as in the case of so-called embalming with certain poisonous mineral substances.

The detection of the absorbed poison in the organs, as the liver, spleen, kidney, etc., is justly regarded as a more satisfactory proof of poisoning than the mere discovery of it in the stomach. Indeed, it is by some considered as positive and incontrovertible evidence. This statement is correct in a majority of cases. It should not be forgotten that if a poison in a liquid state be introduced into the stomach or rectum of a dead body, by means of a tube, in a short time the liquid will diffuse through the walls of the viscus, will come in contact with the adjacent organs—the liver, lungs, pancreas, kidney, spleen, etc.—and will penetrate so as to contaminate them more or less. The same result would occur if the body had been embalmed by the injection into the blood-vessels of some poisonous material, such as arsenic or corrosive sublimate. Now if, after several weeks' or months' interment, a suspicion be aroused that the death had been caused by poison, and the body then be opened, very decided evidences will be afforded by the different organs of what might very naturally be mistaken for absorbed poison.

Cases of post-mortem imbibition of poisons are rare; indeed, some have denied its occurrence; but Orfila proved its possibility by his experiments, more than sixty

years ago, and there is good reason to believe that such cases have occurred since then. The author is familiar with the facts of one of this nature, the particulars of which were communicated to him; and in order to establish the possibility of its occurrence, together with the circumstances most favorable for its production, he had a series of experiments made, under his supervision, by Dr. Geo. McCracken, of the University of Pennsylvania, on the bodies of dogs and cats, with solutions of arsenous oxid, corrosive sublimate, and tartar emetic, confining his experiments, for the time, to mineral poisons. These solutions were severally injected into the stomachs of the animals, and their bodies were buried for periods, respectively, of three, five, six, and seven weeks, when they were disinterred, opened, and the different viscera subjected to careful analysis, with the following results: After three weeks' burial, in the case of all the poisonous solutions, the characteristic colored spots of the respective sulphids were seen on the spleen, under surface of the liver, and that portion of the peritoneum posterior to the stomach: yellow in the case of arsenic, red in the case of antimony, and black in the case of mercury. Each of the metals was likewise discovered by analysis in the liver, spleen, and left kidney, the greatest amount being found in the spleen; next, in the portion of the liver joining the stomach; then in the left kidney; and next in the portion of liver farthest from the stomach, and none in the right kidney. After six and seven weeks' interment, the colored sulphid deposits were much more decided, being noticed on the upper, as well as the lower, surface of the liver, together with the spleen, intestines, omentum, and both kidneys, and, in the case of arsenic, even extending as low

as the fundus of the bladder. The poisons were detected in all the above-mentioned organs.

The inference from the above facts would naturally lead to the necessity of considering the question of the post-mortem introduction of the poison, in every toxicologic investigation. It is evident that it would often not be a very difficult matter secretly to introduce a poisonous liquid into the stomach of a dead person, and, after the lapse of a few weeks or months, to circulate the rumor of the death having been produced by poison. This would probably lead to the disinterment of the body, and the analytic examination would reveal the existence of the poison, not only in the stomach, but also in the liver and other viscera. The conclusion then would naturally be that the individual had died from poison, because it had been discovered in the organs. The case may occur (as has actually occurred) in which there was a strong suspicion of death from arsenical poison, but in which the body was embalmed immediately after death by the injection of an arsenic solution into the abdomen, with the intention, doubtless, of confusing the results of analysis.

Now, the all-important question here is: Is it possible to discriminate, by a post-mortem examination of the liver and other organs of the body, between a genuine case of poisoning and one in which these same organs had become affected by post-mortem imbibition? Certainly not by merely analytic tests, since these would afford similar results in both cases. Until quite recently it seemed that a poison injected into the stomach or bowels of a dead body, or in the process of embalming, could not penetrate through the bony cavities of the cranium and spinal canal, by osmosis, as we know to be the case with the different organs of the abdo-

men and chest. Nevertheless, certain experiments in this line, performed by Dr. G. B. Miller and Mr. F. S. Sutton, of Philadelphia, do seem to prove that a solution of arsenous oxid (and, inferentially, other poisons), injected into the stomach of a dead animal, can, after a sufficient lapse of time, be discovered in the brain and spinal marrow, and even in the bones of the cranium, by the usual analytic reagents. But how this diffusion can be accomplished through the bony walls of these cavities is difficult to understand.

The results of some later experiments of Dr. Miller indicate that strychnin (and presumably the other alkaloids), when injected into the stomach of a dead rabbit, will penetrate by imbibition into the liver, spinal cord, and bladder; the poison having been detected in these localities, though not in the brain.

Experiments made by Vaughan and Dawson, and also by Witthaus, on human cadaver, have shown that comparatively rapid diffusion of poison may occur when it is introduced after death. In one experiment (Witthaus) the brain contained .00828 grams of arsenous oxid five days after the injection of 16.56 grams in solution into the stomach. Even the long-continued external application of cloths containing arsenical solutions has resulted in absorption into the abdominal viscera, as in a case reported by Mason.

If, however, these experiments should be verified or extended, the result will be to deprive us of an important means of discrimination. Probably, the next best criterion in such an uncertainty is the fact alluded to by Orfila that, in a case of true post-mortem imbibition, the poison would be found on the exterior rather than on the interior of the

organs; while in a real case of poisoning, the absorbed poison would always be equally deposited in the interior of the organs.

Again, the discovery of the poison in the solid state in the stomach might be regarded as strong evidence of ante-mortem administration; but the finding of a liquid poison in that organ, although strongly suggestive, is not positive proof of the same, since, as we have seen, it is possible to inject such a liquid into this cavity after death.

Still another aid in this investigation is afforded by testing the urine. The discovery of the suspected poison in this secretion might be regarded as conclusive evidence of ante-mortem administration. But even this is open to the possible objection that the bladder, in common with the other abdominal viscera, might be contaminated by imbibition of the injected poison, which might thus possibly affect the contained urine. Probably the most satisfactory and scientific diagnostic mark would be the microscopic proof of a histological and pathological change wrought in the tissue or organ impregnated with the poison. This could only occur by absorption of the poison during life; such changes are not induced by poisons introduced into the dead body. It is very certain that this important subject requires further attention on the part of experts.

Analysis sometimes fails entirely to discover the poison after death, and for this failure several good reasons can be assigned: (1) It may all have disappeared before death by vomiting and purging, and by elimination through the secretions. Arsenous oxid, however, is very apt to adhere to the mucous lining of the stomach, in spite of long and violent vomiting. (2) It may be undiscoverable by tests at present available. (3) Loss by absorption and elimination

may occur. This is apt to be the case when the dose of the poison was only just sufficient to cause death, and death not very rapid. (4) The decomposition of the poison in the blood or during its elimination. This is much more apt to occur with organic than with inorganic substances. (5) Its possible decomposition in the dead body. This does not occur with the mineral poisons; although the chemical composition of these may undergo change after death, as, *e. g.*, arsenous oxid into the yellow sulphid, yet the element remains. (6) The presence of one or more ptomaïnes may seriously complicate the detection of some poisons.

In performing a toxicologic analysis, certain rules should be observed. The examiner should, if possible, inform himself of the character of the symptoms, and, if the case was fatal, of the post-mortem appearances, as these will usually indicate to what particular class of poisons he should direct his researches. In searching for the more complex organic poisons, it is a good plan to reduce the liquid, by evaporation at a gentle heat, to a very small bulk, since a minute quantity of a poison diffused through a large amount of water may fail to respond to the proper tests. It is best, also, to operate on one-half of the material, reserving the other portion in case of accident or for further experiments. The suspected substance ought to respond to all the recognized tests, the characteristic ones being first applied; and in metallic poisoning it is often required to produce the element as evidence. This can always be accomplished without much difficulty in the case of arsenic, mercury, antimony, copper, lead; but it should also be remembered that the results are modified by the quantity of the reagent employed. Reliance should

not be placed on the mere color of precipitates, as this is often fallacious, from being disguised by admixture with foreign matters, or uncertain, from its resemblance to other substances. As instances may be cited the impure arsenic and antimony sulphids, the precipitates in the liquid tests for arsenic, and the resemblance between the action of ferric salts upon the saliva and upon hydrogen cyanid. Finally, the analyst should be careful to test the purity of all his reagents, remembering that many of the so-called pure reagents often contain impurities, which may seriously damage his examination. As an example of the liability of reagents to contain impurities, the case recently reported by Vaughan may be cited. Fifty cubic centimeters of a sample of ether, sold as pure and intended for use in analytic work, was found to contain an organic body of such poisonous character that it killed a guinea pig in ten minutes.

IV. Evidences from Experiments on Living Animals.—When the poison cannot be identified by the symptoms, post-mortem lesions, and chemic tests, the suspected material may be introduced into a living animal, and its effects noted. In the case of strychnin, the frog would be appropriate as a corroborative test. Birds are not so well adapted for experiment. The character of the information thus derived is confined to the mere fact of poisoning, together with some of its physiologic and pathologic actions. By this means the presence of digitalin was identified in a celebrated French case, and aconitin in the case of Dr. Lamson, in England.

The material to be employed in such cases is usually the matters vomited, or that found in the stomach and bowels

of the deceased; but the examiner should avoid a too hasty conclusion, inasmuch as disease might cause the secretions of the alimentary canal to become infected, and thus to act upon the animal poisonously, although no poison had really been taken by the deceased; and, on the other hand, although poison may originally have been present in the stomach, it might have all been expelled by vomiting, or undergone decomposition, so that the contents of the stomach would no longer produce a poisonous impression on the animal. When the quantity of the material is small, as in the case of an ultimate vegetable extract, it is advisable to introduce it into a very small animal, as the mouse, hypodermically.

Another fact to be noticed in this connection is that a poison may be introduced into the human system through the body of an animal, without the latter being affected by it. A case is recorded where a family exhibited all the evidences of belladonna-poisoning after partaking of a rabbit pie; the defense, which was successfully set up, was that the animal had previously eaten of the belladonna plant, by which its flesh had become poisonous. It is well known that the cow and goat will feed upon stramonium with impunity, and that their milk will act poisonously upon those who partake of it.

V. Evidences derived from Circumstances.—The medical expert is not directly concerned with this sort of testimony, and it is best for this feature of the question to be left to the legal authorities. In poison cases, however, the medical and other evidence is so closely connected that the expert may be consulted in regard to the latter. These "circumstances" are the following: (1) *Any suspicious*

conduct of the accused before the event. (2) *Proof of the purchase and possession of poison by the accused.* Of course, this may be satisfactorily accounted for; though often remarkable reasons are assigned by the accused, as in a New Jersey case, where a woman was tried and convicted for attempting to poison her son with successive small doses of croton oil; the alleged reason for its purchase and possession being that it was for the cure of her corns. (3) *The proof of administration in the food or drink of the deceased.* (4) *A sufficiently strong motive for the act.* (5) *Suspicious conduct of the accused during the illness and after the death of the deceased*—such as preventing his obtaining medical advice; assuming the exclusive care of the person, as to the giving of his food or administering the medicines; carefully removing and disposing of all vomited matters, together with the excreta; and expressing the opinion of the probability of a speedy and fatal termination of the case; and, after the death, opposing an autopsy, hastening the burial, and giving a false account of the illness.

Certain questions will naturally present themselves in every case of poisoning that comes up for trial: (1) *Is the death or sickness to be ascribed to poison?* This question is fundamental, as it compels the expert to exhibit his proofs of the poisoning. (2) *What is the nature of the alleged poisoning?* It is rarely in the power of the toxicologist to exhibit the *identical* poison that caused the death, as the *corpus delicti.* In most cases, all that is possible to do is to demonstrate all the known chemic and (occasionally) physiologic tests. In the case of the mineral poisons, it is deemed sufficient to exhibit the element and the results of the recognized chemical reactions. In some cases of mineral poisons, however, it is possible to extract the identical

substance that was administered—such as arsenous oxid, corrosive sublimate, tartar emetic, etc.—by the process of *dialysis.* (3) *Was the substance administered capable of causing death?* If it can be shown that the substance, although criminally administered, was not poisonous, although supposed to be, it would not be possible to establish a case of poisoning; neither, if the substance were poisonous only in large doses, as oxalic acid, and a very small quantity, only a few grains, had been given. (4) *Was the poison taken in sufficient quantity to produce death?* The discovery of a large amount of poison in the body is a pretty sure evidence of the cause of death; but the finding of only a minute quantity, or its total absence from the body, is not positive proof that death was not caused by poison. (5) *When was the poison taken?* This question can generally be answered by referring to the time of the first appearance of the symptoms, together with their duration; but it is affected by various conditions. (6) *May the poison have entirely disappeared from the body without leaving any trace?* The answer must be affirmative if the person has survived long enough to allow of its complete elimination. (7) *Might the poison found in the body be ascribed to any other source than to poisoning?* Not as a general rule, if it is found in considerable quantities, and in the *absorbed* state in the organs, although the possibility of post-mortem imbibition should not be forgotten. But if in *minute* quantity, it might have been introduced medicinally or accidentally. (8) *Can poisoning be pretended?* Undoubtedly, just as various diseases are feigned for some special motive. The idea of being poisoned is a very common delusion of the insane.

This summary is chiefly from Tardieu.

Classification of Poisons.—Of the numerous classifications of poisons which have been proposed at various times, one only requires notice here. This, which may be termed the physiologic, has reference to the effects of poisons upon the healthy system, and, as adopted in the present treatise, is founded upon the latter arrangement as being the most philosophic. It is based upon the one proposed by Taylor, with a few modifications which render it simple and convenient.

All poisons are divided into two Classes: I. Irritants; II. Neurotics.

I. *Irritants.*—These include such poisons as produce an irritant action upon the mucous lining of the alimentary canal, the effects being nausea, vomiting, purging, pain in the abdomen, cramps in the stomach and other parts of the body; the matters vomited and purged being at times mixed with blood. The post-mortem lesions are more or less inflammation of the gastro-intestinal mucous membrane; sometimes ulceration, perforation, and gangrene.

The Irritants may be divided into the Corrosives and Irritants proper. The former produce local destruction of tissue, the effects of which often overshadow the true internal action.

II. *Neurotics.*—These are so named on account of their specific action on the great nervous centers. The symptoms are altogether distinct from those of the former class, being directed especially to the brain and spinal cord. These are drowsiness, giddiness, headache, delirium, stupor, coma, and sometimes convulsions and paralysis. They are naturally subdivided into three Orders: (1) Cerebral, (2) Spinal, (3) Cerebro-spinal. The first of these Orders comprises Narcotics and Anesthetics. The second Order in-

cludes those which act directly upon the spinal cord, such as strychnin; they are sometimes termed Tetanics. The third Order comprises those which influence both the brain and spinal marrow, producing delirium, coma, convulsions, and paralysis. These latter may be grouped under the three heads of Deliriants, Depressants, and Asthenics. The above arrangement is to a great extent an arbitrary one, and must, of course, be somewhat imperfect, as the boundary line between the different classes and orders of poisons cannot always be accurately drawn.

CORROSIVE IRRITANTS.

MINERAL ACIDS.

The Mineral Acids—**Sulphuric, Nitric, and Muriatic**—possess certain common characters, and produce certain common effects upon the system, and may properly be considered together. This action is largely local, although death is sometimes due to the shock upon the nerve-centers. They are seldom used for homicidal purposes, except in the case of young children; they are occasionally employed by suicides, but more frequently cause death by accident.

Their symptoms are exhibited immediately on being swallowed; these consist of a burning in the mouth and throat, with intense pain in the stomach, attended with constant vomiting of a brownish or blackish matter, often mixed with blood, together with mucus and shreds of detached mucous membrane. The ejected matters are intensely acid, and if they happen to fall upon a marble slab they produce effervescence; they also change the color and destroy the texture of the cloth or other material on

which they may fall. Swallowing is very painful, and sometimes impossible. Thirst is intense; the bowels are constipated and the urine diminished. The pulse is small and weak, and the skin cold and clammy. Respiration becomes difficult, and the countenance expressive of great anxiety. There may also be cough and difficulty of speaking. Death may occur from suffocation when the force of the acid is spent upon the glottis and upper portion of the windpipe. The mouth is excoriated and the lips are stained and shriveled. When the acid has been poured far back down the throat, in the case of infants, the mouth and lips may entirely escape injury, the corrosive action being confined to the glottis and adjacent parts. The mental faculties usually remain clear until near death.

The result is generally fatal, although the period of death may vary from a few hours to weeks or months, death often taking place as a result of injury done by the poison (*e. g.*, stricture of esophagus, destruction of mucous coat of stomach).

Post-mortem Appearances.—Stains of a brownish or yellowish hue are apt to be found on the lips and cheeks; also on portions of the dress of the deceased. The lining of the mouth and tongue is shriveled and eroded, stained yellowish in the case of nitric acid, and sometimes of a whitish color. At times the mucous membrane of the windpipe appears to have suffered most from the corrosive action of the poison, and cases are reported of sulphuric-acid poisoning in which all other parts of the body had entirely escaped. The lining membrane of the esophagus is usually softened, detached in long shreds, and deeply congested; the stomach contracted, often perforated, sometimes blackened, containing a dark grumous liquid; at other times it presents a yellowish ap-

pearance. The intestines are likely to be inflamed, unless the death has been very rapid. If the contents of the stomach have escaped into the cavity of the abdomen, through perforation, the peritoneum will be found intensely inflamed, with more or less of dark, effused blood.

Treatment.—No remedies are likely to prove efficient when an undiluted acid has been swallowed. The proper treatment consists in administering baking soda, chalk, or magnesia, stirred up in water, barley water, flaxseed tea, oil, etc. The stomach pump should not be employed, on account of the risk of perforating the softened esophagus.

Sulphuric Acid.—This acid is commercially named *Oil of Vitriol.* In its concentrated state it is a heavy, oily liquid, of a light brownish color ; sp. gr., 1.845 ; intensely sour.

The highly *diluted* acid is colorless and non-corrosive ; paper which has been dipped into it and dried by a gentle heat will be charred.

Sulphuric acid is more frequently the cause of death than the other mineral acids. Homicidal deaths are occasionally met with among infants, and several cases are reported where it was introduced into the rectum and vagina. The *fatal dose* for an adult is about a fluid drachm ; for an infant, half this quantity ; but the danger depends more on the degree of concentration than upon the absolute quantity swallowed. Death usually occurs within twenty-four hours, and in cases where its action is spent upon the *rima glottidis*, producing suffocation, the fatal result may be almost immediate. According to Casper, the bodies of those poisoned by sulphuric acid resist putrefaction for a long period.

There seems to be reason for believing that this acid

is absorbed into the circulation and eliminated by the secretions.

"Vitriol throwing"—that is, the throwing of strong sulphuric acid on the person of another—occurs occasionally, the motive being generally revenge or jealousy. Much local injury is often produced. *Copious* effusion with water is the best treatment.

Analytic Methods.—The concentrated acid is recognized by its oily appearance; it chars organic bodies; it evolves considerable heat when mixed with an equal bulk of water. The diluted acid is easily detected by its producing, with barium chlorid, a white precipitate insoluble in nitric acid. To confirm this result, the precipitate (barium sulphate) should be dried and mixed with some reducing agent (charcoal, potassium ferrocyanid), and heated to redness; the barium sulphate is by this means converted into the sulphid, and when this is moistened with diluted hydrochloric acid the smell of hydrogen sulphid is at once perceived, proving the presence of sulphur.

Several other acids besides sulphuric give white precipitates with barium salts, but nitric or hydrochloric acids will dissolve these, while the sulphate remains unaffected.

Any sulphate will produce the same precipitate with barium chlorid as the free acid. The two may easily be distinguished by heating a little of the liquid in a watch-glass over a steam-bath. Sulphuric acid does not dry up, while a solution of a sulphate will form crystals. The solution contains both the free acid and some soluble sulphate; finely powdered barium carbonate should be added, first warming the liquid; this will precipitate the free sulphuric acid only; hence the resulting barium sulphate will represent all the free acid present.

Another delicate test is veratrin. A small portion of this alkaloid is introduced into the diluted acid and carefully evaporated to dryness; a beautiful crimson-purple color is developed. Moreover, as this test produces no effect upon a sulphate, it serves to distinguish the latter from the free acid.

Toxicologic Examination.—The organic matters, if thick and viscid, should be boiled with the addition of distilled water, and the solution filtered, and a measured portion, acidified by hydrochloric acid, precipitated hot by barium chlorid, and the precipitate washed and dried. This precipitate may be reduced by heat and potassium ferrocyanid, and further tested as mentioned above.

It might happen that the solution contained a soluble sulphate along with some other acid—citric, acetic, etc. The mode of distinguishing this from a solution containing free sulphuric acid is as follows: a given volume of the solution is acidulated with acid, and precipitated with barium chlorid, and the precipitate washed, dried, and weighed. An equal volume of the original solution is evaporated to dryness, and heated in order to drive off any free sulphuric acid, and is then dissolved in pure water, filtered and precipitated as before, and the dried deposit weighed. If the weight of each of these precipitates is equal, there was no free sulphuric acid present; but if the weight of the former precipitate exceeds that of the latter one, then the excess of weight will indicate exactly the amount of the free acid present in the original solution. The evaporation of sulphuric acid must be conducted under good ventilation, as a few drops of it will render a large room almost uninhabitable.

Tardieu and Roussin recommend the following process

(which is also adopted by Blyth) for determining free sulphuric acid when associated with a sulphate. The object is to saturate the free acid with a base, the sulphate of which is soluble in alcohol: this base is quinin. To a measured portion of the suspected solution, quinin, recently precipitated and washed, is added in slight excess, and the whole evaporated on a water-bath. The semi-liquid extract which remains is exhausted with absolute alcohol; the alcoholic solution is evaporated, filtered, and evaporated anew, and the resulting extract dissolved out in a small quantity of boiling distilled water, and immediately filtered. If the amount of free sulphuric acid is at all considerable, the quinin sulphate crystallizes out on cooling; but if small, and in either case, the presence of the acid can be proven by the barium test.

It may happen that in consequence of the alkaline antidotes administered all the acid will have been neutralized, and only sulphates be found in the vomit and in the stomach. In such a case it will be impossible for the toxicologist to prove by the analysis alone the fact of poisoning by sulphuric acid, since in the ordinary contents of the stomach and bowels sulphates are always present. Consequently, further evidence of the poisoning must be sought for in the symptoms, post-mortem lesions, and attendant circumstances.

Detection of Stains on Clothing.—The color of the stains made by sulphuric acid on dark cloth is at first red and later brownish, and they may retain moisture for a long time. The moisture adherent to the charred hole made by this acid in clothing will distinguish it from one made by a heated body, which is always dry. To recognize the acid, a few of these spots should be cut out of the garment and

boiled with a little distilled water and tested with the barium chlorid. A portion of the unaffected cloth should also be tested at the same time in order to show the absence of any sulphate.

Quantitative Analysis.—Sulphuric acid is estimated as a sulphate; the precipitated barium sulphate, after careful washing in hot water, with a little hydrochloric acid, is collected on a filter, dried, and weighed; 100 parts of the sulphate are equal to 42.02 parts of sulphuric acid (H_2SO_4).

Nitric Acid (*Aqua Fortis*).—As found in commerce, this is a powerful acid, of a yellow or orange color. Sp. gr., 1.35 to 1.45. It is apt to be contaminated with sulphuric acid, chlorin, iron, and various nitrogen oxids. It is seldom used as a poison. Orfila relates a case where a man poured this acid into the ear of his drunken wife, which caused her death by inflammation of the brain and destruction of the bones seven weeks afterward. This, however, might not be regarded as an instance of poisoning.

Symptoms.—Similar to those caused by sulphuric acid, except that the lips, tongue, and inside of the mouth are stained yellow. Spots upon the cheeks, neck, and other parts of the body, and of the dress, are also yellow and very permanent. The teeth are white, but yellowish at their junction with the gums. The purging is sometimes accompanied with blood. The vapors of this acid have caused death in several instances.

Fatal Dose.—Two drachms of the concentrated acid have proved fatal to an adult, although larger doses have been taken with impunity. Life is usually destroyed within twenty-four hours, but frequently it is protracted, and in one case death did not occur for seven months.

Treatment.—This is essentially the same as that recommended for sulphuric acid.

Post-mortem Appearances.—The lips, tongue, and inside of the mouth present a yellow or yellowish-brown appearance; the mucous membrane of the esophagus is colored yellow, softened, and peels off in pieces; the larynx and glottis may have suffered, as in the case of sulphuric acid. The stomach may be distended, presenting a greenish color, due to the action of the acid on the bile; it may be found in a pulpy state, perforated, and adherent to the adjacent viscera, and even partially destroyed. The contents have usually a yellow color; the lining membrane is deeply congested and the vessels filled with dark blood; sometimes the open mouths of the vessels can be seen. The upper portions of the intestines may exhibit the same appearances as the stomach. The large intestine is apt to escape. In chronic poisoning there is great emaciation; and, after death, contraction of the pylorus, with softening of the mucous membrane, has been found.

Analytic Methods.—The concentrated acid is recognized by (1) the odor when exposed to the air; (2) by leaving no residue when heated in a watch glass; (3) by giving off dense orange-red fumes when poured on fragments of copper (the dilute acid requires to be boiled on these metals to produce the same result); (4) by producing a brown color with a strong solution of ferrous sulphate.

The dilute acid is tested as follows: (1) add barium chlorid and silver nitrate to separate portions of the substance; no precipitates will form. (2) Boil with fragments of copper; red fumes will be evolved. (3) Neutralize with potassium carbonate and moisten a piece of filtering paper in the resulting solution (potassium nitrate); when the

paper is dried it will scintillate on burning, like touch-paper. (4) Evaporate the above solution until crystallization; examine the crystals with a magnifier (potassium nitrate forms six-sided striated prisms). If the solution be neutralized with sodium carbonate the crystals will present the cubic form of sodium nitrate. (5) Put a fragment of these crystals into a small test-tube along with a little copper filings and a few drops of sulphuric acid and water; slightly heat, when there will be an escape of orange-red fumes and the production of a blue liquid (copper nitrate). (6) Proceed as in (5), but instead of copper filings add a fragment of morphin, when an orange-colored solution will result, the color becoming fainter on boiling. (7) As in (5), substituting for the copper a crystal of brucin, which will yield a blood-red color, disappearing on the addition of stannous chlorid. (8) Proceed as in (5), except, instead of using copper filings, add an excess of sulphuric acid and allow it to cool; then pour in gently a freshly-prepared solution of ferrous sulphate; a brown color is immediately formed at the line of junction; if heated, the color disappears with the evolution of the orange-red fumes. (9) As in (5), using a crystal of narcotin instead of copper; a reddish-brown color is produced, changing by gentle heat to a blood-red. (10) If a small portion of the crystals obtained in (4) be mixed with a solution of phenol in strong sulphuric acid, heated gently for a few minutes in a steam-bath, diluted with water, and neutralized by sodium hydroxid, a yellow solution of sodium picrate will be obtained.

Toxicologic Examination.—First, test the organic matters (as contents of the stomach, etc.) with litmus paper; the acid may have been neutralized by the alkaline antidotes. If viscid, add a sufficient quantity of distilled water and boil

gently for about a quarter of an hour; filter; if found to be acid, a trial test may first be made by boiling a portion of it in a test-tube with copper filings; it may next be neutralized with potassium carbonate and crystallized by evaporation; drench the crystals with strong alcohol to remove impurities, and test them by the methods above described. If the matters examined are not acid, but have been neutralized by chalk or magnesia, the nitrates so produced may be decomposed by potassium carbonate and the resulting potassium nitrate strained from the filtered solution.

The urine should always be examined for nitrates by distillation with sulphuric acid, neutralizing the distillate with potassium carbonate and proceeding as above.

The tissues may be examined as follows: Make a mixture of equal parts of sulphuric acid and water, and put twenty or thirty drops into test-tubes.

To (1) add a little brucin; no change should result. Add now a little piece of the tissue to be examined, when the solution, if nitric acid be present, will turn a blood-red color.

To (2) add a few grains of copper filings and a piece of the tissue, and boil. The evolved reddish vapors, if nitric acid be present, will give a blue color to a piece of white paper moistened with a solution of potassium iodid and starch.

To (3) add a solution of ferrous sulphate; on adding a piece of the tissue, the solution will become of an olive-brown color if nitric acid be present.

Suspected stains are examined by soaking the fabric or other substance in warm distilled water. If acid, the solution should be neutralized with potassium carbonate, and

the resulting crystals treated as above directed. The color of these stains, as before mentioned, is yellow; they can be distinguished from stains of iodin and bile by the application of a weak solution of potassium hydroxid, which intensifies the nitric stain, whilst it discharges the iodin (or bromin) stain, and does not affect the bile.

Hydrochloric Acid.—This acid, known commercially as *Muriatic Acid* and *Spirit of Salt*, as usually found has a light yellow color, fumes when exposed to the air, is powerfully acid, and has a sp. gr. of about 1.15. When pure it is colorless; its yellow hue is due to ferric chlorid or organic matter. The commercial acid frequently contains arsenic and antimony and other impurities. Instances of poisoning by it are comparatively rare, except as the result of accident.

Symptoms.—These are, generally, similar to those occasioned by the other mineral acids. A grayish or white appearance of the tongue and interior of the mouth, with the formation of a false membrane, is usually observed.

Fatal Dose.—Half an ounce for an adult; a drachm has destroyed a child. The *fatal period* varies from a few hours to many weeks.

The *treatment* is the same as that above described for the other mineral acids.

Post-mortem Appearances.—These, on the whole, resemble the lesions found in cases of death from the other two acids, although they more closely assimilate the appearances produced by sulphuric acid, in the blackened or charred ridges often noticed in the interior of the stomach. The esophagus presents a denuded appearance from the detachment of its mucous membrane. The glottis and larynx

may also be deeply injected and corroded in cases where the poison has spent its effects on these organs.

Analytic Methods.—The strong acid is distinguished from other acids (1) by its yellow color; (2) by its giving off dense white fumes in contact with ammonium hydroxid, shown by holding the stopper of the ammonium hydroxid bottle over the solution supposed to contain the acid; (3) by its negative action on copper or mercury, even when heated; (4) by its evolving chlorin when heated with manganese dioxid.

The dilute acid is detected by a solution of silver nitrate, which gives a white, curdy precipitate of silver chlorid that soon darkens on exposure to light, is insoluble in boiling nitric acid, but very soluble in ammonium hydroxid. When dried and heated it fuses into a yellow liquid, which on cooling becomes a soft, horny mass. As any soluble chlorid—*e. g.*, common salt—will yield the same precipitate with silver nitrate, a drop of the original solution should be evaporated on a glass slide; if it was free acid it will all disappear; if a chlorid, a residue will be left.

Silver nitrate forms precipitates with other substances; but all, with the exception of that from cyanids, dissolve in nitric acid. The silver cyanid is soluble in boiling nitric acid, and is further distinguished by its crystalline appearance, and by yielding, when heated, cyanogen gas.

Toxicologic Examination.—As this acid is volatile, a distilling process may be applied. The organic matters (such as the contents of the stomach, together with the viscera, properly cut up) should be put into a glass retort with a small quantity of pure water, and distilled nearly to dryness. The first portion of the distillate may be rejected, but the

remainder will usually yield the characteristic test with silver nitrate.

The above method, however, is liable to two fallacies: First, there is always apt to be present in the gastric juice of the human stomach a variable quantity of hydrochloric acid; and, secondly, sodium chlorid is frequently found there, being introduced with the food. Consequently, it will not be safe to rest the proof of poisoning by hydrochloric acid on the analysis exclusively. If the symptoms and post-mortem lesions do not indicate death from a corrosive acid, the mere detection of this acid, after death, by the chemical examination would be of no value.

The stains of hydrochloric acid on dark cloth are at first of a bright red color, changing, after some days, to a reddish brown. They may be examined after the method already described. The experiment should, however, be verified by testing another portion of the garment not having a stain.

This acid is sometimes used to erase ink marks in cases of forgery. The paper thus acted on should be treated in the same manner as mentioned for the cloth.

Hydrochloric acid is estimated as silver chlorid, every 100 parts of the latter are equivalent to about 80 parts of acid of sp. gr. 1.15.

ALKALIES AND THEIR SALTS.

THE toxicology of the three alkalies, **Potassium Hydroxid, Sodium Hydroxid,** and **Ammonium Hydroxid,** may properly be considered together. Their effects upon the animal system are analogous, and resemble the impressions produced by the mineral acids, being powerfully

caustic in their concentrated state. They attack the tissues with which they come in contact by virtue of their chemical affinities, causing their disorganization and complete destruction. They are very rarely used for homicidal poisoning, but they occasionally prove fatal as the result of accident.

Potassium hydroxid is commonly known as caustic potash or potassa; sodium hydroxid is known as caustic soda and concentrated lye.

The *Aqua Ammoniæ* of the shops is a solution of ammonium hydroxid in water, and is a highly caustic substance. The first two alkalies, together with their salts, are fixed when heated; the latter is volatilized by heat, by which circumstance they are readily distinguished from each other.

Symptoms.—In the concentrated state they occasion an acrid, nauseous taste, followed by a burning sensation in the throat and stomach; violent abdominal pain, increased by pressure; vomiting of mucous matters, tinged with blood; purging of a similar character, with tenesmus; difficulty of swallowing, hoarseness, and coughing. The pulse is quick and feeble, the countenance anxious; the body is covered with a cold, clammy sweat; the respiration is rapid, with great muscular prostration. Death may ensue in a few hours, or it may be postponed for months, or even years. In the latter cases the fatal result is often owing to secondary causes, such as stricture of the esophagus and of the pylorus, occasioning starvation.

The effects of swallowing strong ammonium hydroxid are similar to those above described, except that they may be more rapid, and affect the organs of respiration by the vapor given off.

The incautious application of this vapor to the nose, in

cases of syncope, is sometimes followed by fatal results for this same reason.

Fatal Dose.—As in the case of the mineral acids, the fatal effects of the alkalies depend rather upon their degree of concentration than upon the actual amount swallowed. Half an ounce of potassium hydroxid is the usual fatal dose; but an ounce and a half of the solution of the shops, containing about forty grains, has caused death. Strong ammonium hydroxid has proved fatal in the dose of two drachms; recovery has occurred after swallowing over an ounce. Instances of recovery are more frequent from this than from the fixed alkalies.

Treatment.—The stomach-pump should never be used. Dilute vinegar or lemon juice should be freely given, together with oil or other demulcents. Opium may be used to quiet pain, and stimulants to counteract the depression. The inhalation of acetic acid might prove beneficial in poisoning by vapor of ammonium hydroxid.

Post-mortem Appearances.—The lining membranes of the mouth, throat, esophagus, and stomach exhibit evidences of corrosion in their softened and abraded condition; at times the mucous coat of the stomach is blackened from the effused blood, and may be completely destroyed. The larynx and bronchi may be inflamed and softened, especially with ammonium hydroxid. In chronic cases the mucous membrane of the esophagus may be much thickened, and its caliber, as also that of the pylorus of the stomach, extremely contracted.

Chemical Properties.—All the alkalies neutralize acids, turn turmeric paper brown, and restore the blue to reddened litmus. They are not precipitated by hydrogen sulphid, ammonium sulphid, or ammonium carbonate. Cor-

rosive sublimate causes a yellowish precipitate with the fixed alkalies and a white one with ammonium hydroxid.

Potassium hydroxid is distinguished from sodium hydroxid as follows:

(1) Platinum chlorid produces, with the former, a yellow potassium platinum chlorid which, under the microscope, is seen to be in octahedral crystals. This reagent will also precipitate ammonium compounds; hence, in an analysis, the absence of the latter must be insured. Ammonium can readily be detected by heating a little of the suspected liquid in a test-tube with lime or magnesia; the vapor may be recognized by its odor and by its action on turmeric paper.

(2) Tartaric acid throws down from a strong solution of potassa, or its salts, a white crystalline precipitate—potassium acid tartrate. This action should be facilitated by adding a little alcohol and stirring with a glass rod. Here, also, the absence of ammonium compounds must first be proved.

(3) Neutralize the solution with nitric acid and evaporate on a steam water-bath. The resulting crystals are readily identified. Potassium nitrate is in six-sided striated prisms; sodium nitrate in cubes.

(4) Heated on a loop of platinum wire in the Bunsen-burner flame, potassium compounds give a violet flame, sodium compounds a yellow flame. The spectroscope easily distinguishes the two bodies in presence of each other. Sodium gives a yellow line, which is double when examined with a good instrument. Potassium gives two lines, one dark red and the other violet.

Since sodium compounds occur abundantly in many animal fluids, especially blood and urine, and potassium

compounds are also present, it is obvious that the finding simply of these elements in combination will not prove poisoning. It must be shown either that the amount is much larger than normal or that compounds not normal to the body are present.

Toxicologic Examination.—If required to separate a hydroxid from the carbonate, the original mixture must first be evaporated to dryness, and the residue treated with absolute alcohol, which will dissolve out the hydroxid but not the carbonate. After filtration, evaporate to dryness and incinerate; dissolve the residue in water and test as above directed.

Quantitative Determination.—Potassium is estimated by mixing its chlorid with excess of an alcoholic solution of platinum chlorid. The precipitate should be washed with strong alcohol, dried, and weighed. Every 100 parts of the double chlorid represent 23 parts of potassium hydroxid, or 28.3 parts of carbonate.

Solution of ammonium hydroxid (*Aqua Ammoniæ*) is a colorless liquid having a very pungent odor and an acrid, alkaline taste. It leaves no residue when evaporated to dryness. It gives to a solution of a copper salt a characteristic blue color. It produces white fumes with hydrochloric acid.

The salts of ammonium are colorless, and volatilize when heated; and if, at the same time, they are mixed with lime or potassium hydroxid, they yield the characteristic ammoniacal odor. The other tests for ammonium salts are: (1) platinum chlorid; (2) tartaric acid; (3) Nessler's reagent. The last is made by adding an excess of potassium iodid to mercuric chlorid until the mercuric iodid formed is redis-

solved, an excess being afterward added. It gives an orange or brownish discoloration, with the smallest trace of ammonium compounds.

Toxicologic Examination.—If the mixture be in a state of decomposition, it will be useless to attempt the analysis, inasmuch as ammonium compounds are invariable as a result of putrefactive processes. Distil over about a fourth of the organic liquid, conducting the vapors into a well-cooled receiver containing a little water, and test the solution as above directed. If no ammonium hydroxid be given off, then examine the contents of the retort for an ammonium salt, by first treating with strong alcohol; filter the solution and re-distil, along with slaked lime or sodium hydroxid; this will yield the ammonium hydroxid.

Ammonia is determined, quantitatively, like potassium: every 100 parts of the double chlorid represent 16.5 parts of ammonium hydroxid.

Potassium Nitrate (*Nitre, Saltpetre*).—This salt is much used in the arts, especially for the manufacture of gunpowder; it is likewise employed in medicine in small doses. It occurs in six-sided, striated crystals; taste saline and cooling; very soluble in water; deflagrates when thrown upon hot coals; gives off nitrous fumes when acted upon by sulphuric acid.

Symptoms.—In large doses, and in the concentrated state, it acts as a powerful irritant to the alimentary mucous membrane, causing violent burning pain in the esophagus and stomach; vomiting, sometimes of blood; bloody stools; cold, clammy skin; weak, frequent pulse; collapse and death. Besides these evidences of a local irritant action, it occasions certain nervous symptoms, such as convulsions,

tremors, partial paralysis, loss of speech, and delirium. Occasionally, a very large dose has produced comparatively slight local symptoms, while the impression upon the nervous centres has been more decided.

Fatal Dose.—Death from this compound is generally the result of accident, it having been swallowed by mistake for other salts. An ounce to an ounce and a half, taken in a concentrated state, has frequently proved fatal in a few hours. The largest dose recorded to have been taken is mentioned by Wharton and Stillé. A German, by mistake, swallowed three and a half ounces of this salt. He complained of but slight pain or sense of heat in the stomach, and was purged three times within three or four hours. About five hours after taking the nitre he suddenly fell out of his chair and expired. There was no autopsy. In this case the excessive dose of the poison seemed to have destroyed life by shock. The rigor mortis was very imperfect, and the countenance and lips retained their life-like appearance to a remarkable degree for three days after death.

Post-mortem Appearances.—The lining membrane of the stomach is usually highly inflamed and detached in places; perforation has been observed in one instance. The intestines are often similarly affected. The contents of the stomach are sometimes tinged with blood.

Treatment.—Free vomiting should be promoted by the use of bland mucilaginous drinks; opium and stimulants to relieve pain and depression; together with external applications, as fomentations, etc. There is no chemical antidote.

Toxicologic Examination.—See *Nitric Acid.*—According to Orfila and Wöhler, nitre has been detected in the urine, liver, spleen, and kidneys of those poisoned by it.

Potassium Chlorate.—This salt, so much used in medicine of late years, has not infrequently been the cause of death. Half an ounce has proved fatal to an adult. The symptoms are those of a powerful irritant to the alimentary canal and nervous systems, such as vomiting and purging, general weakness, with rigidity of the limbs, delirium, and coma. After death the blood has been found of a brownish color, thickened, with a tendency to agglutination of the corpuscles. The urine contains blood corpuscles and brownish tube-casts. It has been stated that crystals of the substance have been found in the tubes of the kidney in cases of poisoning.

Potassium Acid Tartrate (*Cream of Tartar*).—This salt is very much used in medicine and is not generally considered to be poisonous; but in large and concentrated doses—two ounces—it has proved fatal, causing symptoms strongly resembling those produced by nitre.

Alum.—This salt, in large doses, is very irritant to the stomach and bowels, producing vomiting and purging, although in small quantities its action is that of an astringent. It has proved fatal to animals, and at least one death in the human subject has been recorded. Commercial alum may be either potassium aluminum sulphate or ammonium aluminum sulphate. The physiologic action of each is practically the same.

Potassium sulphate and potassium acid sulphate are highly irritating in large doses; the former has occasioned death in quantity of ten drachms. It is used sometimes as an abortive. Arsenic compounds have been found as im-

purities of the commercial article, and might in this way get into Dover's powder when made by the older method, in which a large proportion of potassium sulphate was used. The death of a sailor occurred some years ago on a German steamer bound for Philadelphia, and on arrival of the vessel the German consul requested the captain to submit to Dr. Henry Leffmann, for analytic examination, all suspicious materials found among the sailor's effects. About half a pound of potassium acid sulphate was found, and it is not unlikely that some of this substance had been taken, possibly by mistake, although there was suspicion of suicide. The symptoms were those of an irritant.

Large doses of the ordinary purgative salts under certain circumstances may prove powerfully irritating, and even fatal. Instances of death following the administration of overdoses of Epsom salt and common salt are reported by Christison and Taylor.

Chlorinated Soda and Potassa.—Known in commerce as Labarraque's solution and Javelle water, respectively, and much used for disinfecting and cleansing purposes, have occasionally produced fatal effects when swallowed. Tardieu has reported such a case in which a child died some weeks after taking this substance in divided doses. It was identified by the discovery of an abnormal quantity of sodium chlorid in the urine and kidneys; also by the formation of lead chlorid on the leaden mouth-piece of the bottle which contained the poison, and likewise by characteristic stains of a reddish-white color on the child's cap.

Barium Salts.—All the soluble compounds of barium are poisonous. They occasion symptoms analogous to

those caused by potassium nitrate, such as pain in the stomach, vomiting, and purging, with decided nervous symptoms and palpitation of the heart. The post-mortem lesions are inflammation of the mucous coat of the stomach and bowels, great congestion of the brain and lungs, and the heart full of dark blood.

The proper treatment is to promote the evacuation of the poison by the use of emetics and mucilaginous drinks and the free administration of sodium sulphate or magnesium sulphate, and the subsequent use of antiphlogistic remedies.

IRRITANTS PROPER.

THIS subdivision of the **Irritants** includes such poisons as, besides producing inflammation of the gastro-intestinal mucous membrane, cause other symptoms, which indicate an impression on the great nervous centres. Several of the alkaline and earthy salts already described are of this character, and might have been considered under this head.

PHOSPHORUS.

Phosphorus, in combination, is largely diffused as a constituent of the animal body. Its presence is essential to the performance of its normal functions, and this is especially true in reference to the great nerve-centres, of which it constitutes a comparatively large proportional part. It is eliminated from the system in the urine in the form of phosphates.

In its free state phosphorus is a powerful irritant poison. It it less employed for poisoning in this country and England than in France and Germany, and is seldom used for

homicidal purposes. Fatal results have frequently occurred by its accidental and suicidal employment—chiefly the former, from the swallowing of phosphorus-paste (used for destroying vermin) and the tops of lucifer matches.

Symptoms.—These do not usually appear for some hours after the poison has been taken ; but in some cases they are manifested earlier. There is first perceived a disagreeable taste, and a garlicky odor may be noticed in the breath. This is followed by a burning pain in the throat and stomach, with intense thirst and nausea ; distention of the abdomen, with vomiting and purging ; pupils dilated ; cold perspiration and great anxiety, with small, frequent, and irregular pulse. The matters first vomited generally exhale a garlicky odor, and are luminous in the dark ; their color is green, or like coffee grounds, and they may contain the blue or red fragments of the tops of matches. The discharges from the bowels have also been observed to be phosphorescent. Sometimes convulsions precede death ; again, the patient may die quietly or in a coma. If the case is protracted for some days, jaundice is apt to occur, and likewise hemorrhage from the stomach, bowels, nose, and other parts of the body. In some of its phases the hemorrhagic form resembles scurvy, and, as in the latter disease, there are purpura spots over the body. Paralysis is an occasional result. The urine is highly albuminous, and is apt to be suppressed.

Chronic poisoning, accompanied by all the above symptoms, though in a less violent degree, may result from the inhalation of the vapors of phosphorus in the manufacture of lucifer matches. This form of poisoning comes on very insidiously, and is very apt to be fatal. It generally manifests itself first in the jaws, causing first an inflammation of

the periosteum, followed by caries of the teeth and necrosis of the bone. Some authorities state that this form of necrosis attacks only those whose teeth are decayed. It is further stated that in some match factories it is required that the workmen should have sound teeth.

Fatal Dose.—Less than a grain has proved fatal. Lobel, of Jena, has reported the case of a lunatic who died from taking about the $\frac{1}{10}$ of a grain. A child died after sucking two matches; another older child died from the effects of swallowing the tops of eight matches.

Phosphorus is occasionally employed in medicine, in doses of $\frac{1}{60}$ to $\frac{1}{30}$ of a grain; but even in these small doses its effects are uncertain, and it may sometimes act with unexpected severity.

Fatal Period.—It is not to be classed among the rapidly fatal poisons. It usually causes death in from one to four or five days; in exceptional cases, earlier. Casper quotes the case of a young lady who died in twelve hours after swallowing three grains of phosphorus in the form of an electuary. Dr. Habershon reports a case which proved fatal in half an hour. Cases of chronic poisoning may last for months, or even for years.

Treatment.—There is no chemical antidote known. Free emesis should be encouraged by the use of albuminous and mucilaginous drinks holding magnesia or magnesium hydroxid in suspension. The use of fatty oils is objectionable, as they are solvents for phosphorus, and would consequently tend to diffuse the poison. Oil of turpentine is highly recommended by Dr. Percy as a reliable antidote, if given early and before the poison is absorbed. The old oil, or that which has become oxygenated, is to be employed, not the fresh hydrocarbon. He also recommends the intro-

duction of oxygenated water into the stomach through a tube, and the inhalation of free oxygen into the lungs. Animal charcoal has also been recommended, from its power of absorbing free phosphorus; and likewise silver nitrate, from its power to form an insoluble compound of silver and phosphorus. Copper sulphate also is recommended. These mineral salts are themselves irritant poisons, and can certainly be permissible only in small doses.

Post-mortem Appearances.—According to Tardieu, who has given special attention to this subject, the lesions produced by phosphorus vary according to the form in which it is taken. It is when in the pure state or simply dissolved in oil that it most frequently occasions lesions in the esophagus and alimentary canal. Fragments of phosphorus may be discovered adhering to the mucous membrane, even of the large intestines, and at these spots the bowel is liable to perforation during the examination. In the esophagus, stomach, and intestines ecchymotic or gangrenous spots are scattered about. The mesenteric glands are engorged, and are often soft and friable.

The blood corpuscles undergo, in phosphorus-poisoning, a speedy disintegration, which is doubtless the cause of the ecchymoses seen upon the different organs.

In other cases, as in poisoning by phosphorus-paste, there may be no special morbid appearance, but even in the absence of redness or ulceration there will be ecchymoses, more or less abundant, over the mesentery and visceral peritoneum. The pleural and pericardial sacs contain bloody serum. Irregular bloody spots are scattered over the pleura, pericardium, and even the endocardium. The heart is soft, distended, or contains fluid blood. The blood itself is very dark, fluid, and syrupy; it appears to be com-

pletely devitalized; the corpuscles are disintegrated and transparent, by loss of their coloring matter. In certain cases the mucous coat of the stomach and duodenum is so softened as to break under pressure of the knife; ulcerations also sometimes occur in the stomach. It is stated that the intestines, and even the flesh, of animals poisoned by phosphorus have the odor of garlic, and appear luminous in the dark. This luminosity of the viscera has been observed in the human subject.

The exterior of the body often exhibits an icterode appearance. Sometimes the red or blue coloring matter of the lucifer matches that have caused death may be found adhering to the inside of the alimentary canal a considerable time after death. The general appearance of the gastro-intestinal mucous membrane is hemorrhagic rather than inflammatory, ecchymoses being scattered throughout. The contents of the intestines are liquid and bloody. The bladder contains bloody urine, and often presents sub-mucous ecchymoses.

A peculiar pathological alteration revealed by the microscope as the result of phosphorus-poisoning is fatty degeneration of the liver and other organs of the body. But these peculiarities are not absolutely characteristic of this poisoning, since they occur in poisoning by other agents, as arsenic, alcohol, antimony, etc., and also as the result of disease; nevertheless, they possess especial importance from their association with other notable symptoms of phosphorus-poisoning, such as the jaundice, muscular pains and weakness, diseased condition of the blood, and albuminous urine.

The contents of the stomach in some instances evolve the odor and fumes; and in a case mentioned by Casper, two

days after death luminous vapors issued from the vagina, and a whitish vapor having a phosphorous odor issued from the anus. In this instance no smell or vapor of phosphorus could be detected on opening the stomach ; nor was there any part of its lining membrane either softened or corroded.

Diagnosis.—Generally, in acute cases, there will be no difficulty in recognizing the evidences of phosphorus-poisoning, both from the symptoms and post-mortem lesions, as above detailed. Chronic cases accompanied by jaundice might, however, be mistaken for yellow atrophy of the liver. The following are diagnostic points : The sensation of heat in the throat, eructations and vomiting of matters having a garlicky odor and a luminous appearance, would indicate phosphorus-poisoning. The icterode appearance is not so intense in the poisoning as in the disease, nor is it accompanied with the injection of the eyes or with the fever which mark the latter. The fatty change of the viscera may be seen two days after the ingestion of the poison. According to other authorities, the liver in phosphorus-poisoning is enlarged, dull in appearance, doughy, uniformly yellow, with the acini well marked ; in acute atrophy, the liver is diminished in size, greasy on the surface, of a dirty yellow color, and the acini nearly obliterated. In the former, also, the hepatic cells are either filled with oil globules or entirely replaced by them ; in the latter the cells are filled with a fine granular detritus and thin structure, replaced by a newly-formed connective tissue (Husband).

Chemical Analysis.—Phosphorus is a white, waxy solid, nearly twice as heavy as water, readily fusible and inflammable. It evolves fumes at ordinary temperatures when exposed to the air, and appears luminous in the dark. The smell and taste of phosphorus recall those of garlic, by

which means it may be easily recognized when mixed with food and drinks. The fuming of phosphorus in the air, as also its luminosity, is completely prevented by the presence of alcohol, ether, chloroform, oil of turpentine, and other bodies, even in minute quantities. Although insoluble in water, phosphorus ultimately imparts to it poisonous properties. It is tolerably soluble in fixed and volatile oils by the aid of heat; also in ether, chloroform, and naphtha; its best solvent is carbon disulphid. Nitric acid converts it into phosphoric acid. It is not affected by either sulphuric or hydrochloric acids. It is preserved under water, to protect it from oxidation.

In its free state phosphorus is easily detected by its sensible properties, as already described. A fragment put into the materials for generating hydrogen will evolve hydrogen phosphid, easily recognized by its luminosity in the dark, and from being sometimes spontaneously inflammable. The gas, when ignited at a jet, burns with a greenish-blue flame; when it is passed through a solution of silver nitrate, the latter is blackened by the production of silver. Phosphoric acid is formed in the solution, and may be detected by the appropriate reagents.

Toxicologic Examination.—If the materials evolve whitish fumes, which are luminous in the dark, and have an alliaceous odor, there can be no doubt of the presence of phosphorus. If the mixture be ammoniacal, from putrefaction, sulphuric acid must first be added until the liquid is slightly acid. Sometimes the particles of phosphorus may be separated mechanically from the inside of the stomach and bowels, which, when found, should be carefully washed and set aside. Or the mass may be spread out on a metallic plate and gently heated over a spirit-lamp, when the minute

fragments of phosphorus will take fire and burn with a brilliant light. The suspected particles may be heated under water, when they will melt and run together into a globule, which will solidify on cooling, and may easily be identified.

Carbon disulphid may be used to dissolve out the phosphorus from many organic mixtures, and when phosphorus-paste has been employed. On allowing the solution to evaporate spontaneously, the phosphorus will remain in minute globules, which can readily be examined. If, however, the poison is in solution, or in too minute a quantity for the above tests, it must be examined by the following processes :

Method of Mitscherlich.—The suspected liquid, acidified by sulphuric acid, is to be distilled in the dark, and the vapors conducted through a long glass tube kept cold, the end of which passes into a receiver. On gently heating the retort or flask, the vapors, as they pass through the cold tube, condense and display a distinct luminosity. The phosphorus thus distilled collects with the aqueous vapor in the receiver, to which it imparts the usual garlicky odor. A portion of it, if in sufficient quantity, may likewise collect in the receiver in the form of globules. This test is exceedingly delicate and satisfactory. Taylor states that the head of one lucifer match produced a luminosity which continued for half an hour in the condensing tube.

The presence of solid phosphorus in the distillate would render further experiments unnecessary ; but in the absence of any granules the distillate, after filtration, should be acidified by nitric acid, which will convert any phosphorus into phosphoric acid ; the liquid should then be concentrated by evaporation and tested. If no luminosity has been observed,

the presence of a small amount of the compounds of phosphorus in the distillate is not sufficient to warrant the supposition of poison, since these might have been derived from the food or tissues and carried over mechanically. It should be remembered that it is only free phosphorus that gives out the luminosity by the above process; the distillation of the brain, or any other tissue that contains this substance in combination, never produces it.

Method of Lipowitz.—This consists in boiling the suspected liquid, slightly acidulated with sulphuric acid, with fragments of sulphur, in an apparatus similar to that employed in the method of Mitscherlich, the experiment being conducted in the dark. The sulphur abstracts the phosphorus from even complex mixtures, and combines with it. The boiling is continued for about half an hour, after which the pieces of sulphur are withdrawn and washed in water. They will now emit the peculiar odor of phosphorus, and appear luminous in the dark. On gently heating them with nitric acid, a mixture of phosphoric and sulphuric acids will result. By evaporating this solution to near dryness, to get rid of the sulphuric acid, then diluting and filtering, the phosphoric acid may be recognized by the usual tests. In prosecuting this test, unless the amount of phosphorus is very minute, the luminosity of the vapor may also be observed in the cool tube.

Marsh's Test.—This process is based upon that employed in testing for arsenic. The suspected material, properly prepared, is put into the jar containing the materials for generating hydrogen; the resulting gas is then passed over calcium hydroxid, for the purpose of removing

any hydrogen sulphid ; it is then ignited at the end of the delivery tube, producing a green flame. The phosphoretted hydrogen is luminous in the dark, and affords a black precipitate with silver nitrate.

Phosphorus has been detected in the free state as late as three weeks after death ; but it is very apt to become oxidized in the body, in which case it can only be identified as phosphate.

The method of testing for phosphorus, as phosphates, in a case of suspected poisoning is unsatisfactory, since these salts always exist in association with the tissues and secretions, as well as in many articles of food. The mode of procedure in such a case is to treat the mixture with a little pure nitric acid, and concentrate by evaporation. It is then treated with a slight excess of pure sodium carbonate and evaporated to dryness, and fused in a porcelain crucible. The resulting sodium phosphate may then be tested as follows :

(1) *Silver nitrate* throws down yellow silver phosphate, soluble in ammonium hydroxid and in nitric and acetic acids. Hydrochloric acid converts it into the white chlorid. Silver nitrate also gives a yellow precipitate of silver arsenite with arsenites, which behaves in the same manner as the phosphate : they are distinguished by drying, and heating in a reduction tube : silver arsenite yields a ring of sublimed octahedral crystals.

(2) *Ammonium chlorid and magnesium sulphate.*—This mixture gives with a phosphate a characteristic crystalline precipitate of ammonium magnesium phosphate ; the minutest quantity can be identified by the microscope.

(3) *Ammonium molybdate.*—This reagent produces a yellow, pulverulent precipitate of ammonium phospho-

molybdate; it is insoluble in the strong acids, but soluble in alkaline phosphates, alkalies, and alkaline carbonates.

Red, Amorphous, or Allotropic Phosphorus.—This singular variety of phosphorus is procured by exposing ordinary phosphorus to a heat of 450° F. for a number of hours in an atmosphere deprived of oxygen, when it will change to a brick-red mass, totally unlike the ordinary substance, although retaining its original composition. The difference between the two is shown by reference to the following table:

Common Phosphorus.	Red Phosphorus.
Very poisonous.	Very slightly poisonous.
Evolves a strong odor.	Nearly odorless.
Phosphorescent.	Not phosphorescent.
Melts at 108° F.	Melts at about 500° F.
Transparent.	Opaque.
Almost colorless.	Varies in color from a reddish-black to crimson.
Freely soluble in some liquids.	Nearly insoluble in all liquids.
Flexible.	Brittle.
Oxidizes in the air.	Unalterable in the air.
Unites readily with other elements.	Is acted on by other elements with difficulty.
Nitric acid acts on it with great energy.	Nitric acid produces no effect.

IODIN, BROMIN, AND CHLORIN.

Iodin occurs in shiny, dark, iron-gray scales; it has a peculiar odor and disagreeable taste; when heated it gives off beautiful violet-colored fumes, which are irritating to the nostrils and throat. Sparingly soluble in water, very soluble in alcohol and ether, and also in the aqueous solution of potassium iodid. It is used medicinally in the form of tincture, compound tincture, and ointment.

Symptoms.—Like phosphorus, iodin produces a local irritant effect and a remote influence; the latter the result of using it in small quantities. In large doses it occasions burning heat in the throat; severe pain in the abdomen; vomiting and purging, the vomited matters having the peculiar odor of iodin, sometimes mixed with blood; the color of the matters is yellowish, except when they consist of farinaceous articles, in which case it is blue. The bowels may also exhibit the presence of iodin. Other symptoms are giddiness, headache, thirst, anxiety, convulsions, and fainting.

In chronic poisoning (iodism) the symptoms are nausea, vomiting, purging, pain of stomach, tremors, palpitation, salivation, cramps, general emaciation, and a tendency to absorption of certain glands, especially the testes and the mammæ.

There is a remarkable diversity in the effects of iodin upon the human system, some persons bearing very large doses with little or no suffering, while others are seriously affected by the smallest quantities. Overdoses have occasionally proved fatal, leaving morbid appearances very similar to those produced by the irritant alkaline salts.

Chemical Analysis.—In its free state, iodin may readily be distinguished by its solid form, color, odor, volatility, and its action on boiled starch—quickly turning it blue. When in combination as potassium iodid, the iodin must first be set free (by chlorin or nitric acid), and then the starch-test applied.

From organic mixtures the iodin may be separated by like use of carbon disulphid or chloroform, which dissolve it; watery liquid should be separated and the solvent evaporated at a very low temperature, when the iodin will be left.

If this process fails, on account of the conversion of the iodin into hydriodic acid or into an iodid, it will be advisable to transmit hydrogen sulphid through the mass, properly diluted; this will convert any free iodin into hydriodic acid; then drive off the excess of gas by heat, add potassium hydroxid in excess, filter, and evaporate to dryness. Char the residue at a low red heat, to get rid of the organic matter; pulverize and dissolve in water. Concentrate the solution, and add strong nitric acid and boiled starch, which will develop the iodin, if any be present.

Potassium Iodid.—Although much used in medicine, in large doses it occasionally produces violent effects upon the system, such as headache, griping abdominal pains, thirst, inflammation of the nostrils and eyes, and frequent pulse, together with salivation and a pustular eruption. As found in the shops, it is apt to be considerably adulterated with carbonate.

Bromin.—This is a dark-red, volatile liquid, excessively pungent to the eyes and respiratory organs, having an acrid odor and taste. It is highly corrosive, destroying animal tissues very rapidly. It has occasionally proved fatally poisonous. A case is reported by Dr. Sayre, of New York, of a daguerreotyper who swallowed an ounce of bromin for the purpose of self-destruction. The immediate symptoms were spasmodic action of the muscles of the larynx and pharynx, with great difficulty of breathing, followed by intense burning pain in the stomach, with great anxiety, restlessness, and trembling of the hands. The pulse was rapid, tense, and corded, and respiration greatly hurried. Collapse soon followed, and death took place in seven and a half hours after swallowing the poison.

The post-mortem examination revealed vivid injection of the external coat of the stomach and of the abdominal viscera generally, which were stained of a deep yellow color. Portions of the stomach were softened. Its contents resembled port-wine dregs, and exhaled the odor of bromin. Its whole interior was covered with a thick, black layer, resembling coarse tanned leather. The mucous membrane was very thin and very deeply injected.

Chemical Analysis.—Bromin may be separated from organic matters by means of carbon disulphid or by ether after the method described for iodin. The bromids may be decomposed by chlorin or by a strong acid. Bromin imparts a deep yellow color to boiled starch.

Chlorin is a powerfully irritating gas, of a greenish-yellow color. If inhaled it may destroy life. Chlorin is readily recognized by its smell and color, and especially by its powerful bleaching properties.

ARSENIC.

The term **Arsenic**, as employed in toxicology, always signifies, unless specially qualified, *arsenous oxid*, often, though erroneously, called arsenous acid. The element itself, which is rarely used as a poison, is brittle, of a steel-gray color, volatile when heated, its vapor having a strong, garlicky odor, by which it may be recognized. It is sold, however, under the name of *fly powder*, which is a mixture of the metal and arsenous oxid. It is rather an abundant element, and occurs in a number of minerals.

Arsenic is one of the most important of all the poisons. The facility of procuring it and its ease of administration

contribute greatly to its extensive use both as a homicidal and suicidal agent. Under the name of "Rough on Rats" it is extensively used for the destruction of vermin.

In the arts arsenic finds many uses, as in the manufacture of enamel and glass, composition candles, vermin-killers, dyes and colors, etc. It is used in various alloys, as speculum metal, white copper, and shot; also by ship-builders to protect timber from worms; by farmers to preserve their grain for seed and for washing sheep; and by grooms to improve the coats of their horses. One of the most common anilin colors, anilin red, fuchsin or magenta, is often made by the aid of arsenic acid, and hence the color often contains notable amounts of the element. If we may credit the accounts of travelers, by the inhabitants of Styria and other mountainous countries, to increase their physical powers of endurance. Preparations containing small amounts of arsenic are sold for improving the complexion.

Properties of Arsenous Oxid.—It occurs in commerce either as a heavy white powder or in masses, which are at first translucent but afterward become opaque. It is nearly tasteless. It is slightly soluble in cold water, and there is some difference between the solubility of the crystalline and of the opaque varieties; boiling water dissolves it more freely, but still not in large amount. Its solubility is much increased by the addition of an acid or an alkali, but diminished by the presence of organic matter. It is easily held in suspension in soups, coffee, tea, milk, etc.

When arsenous oxid is heated to a temperature near 400° F., it sublimes in the form of a white vapor, which is inodorous, and is deposited on a cool surface, either as an amorphous powder or in octahedral crystals. If thrown

upon red-hot charcoal it is decomposed, and the vapor will have a garlicky odor.

Symptoms.—The rapidity and virulence of the symptoms depend somewhat on the form of the poison (*i. e.*, whether in solution or otherwise), and also on the condition of the stomach. As a rule, the symptoms do not occur for half an hour or an hour. There is first a sense of faintness, attended with a feeling of heat and constriction of the throat, together with thirst, nausea, and burning pain in the stomach, increased by pressure. Vomiting and retching soon follow; the matters ejected are rarely streaked with blood; they may be variously colored. Purging accompanied with tenesmus comes on, and along with the vomiting may be incessant, though affording no relief to the sufferer. Cramps in the legs are apt to be present, along with great depression, cold sweat, intense thirst, and a feeble, frequent pulse. The whole train of symptoms may resemble a severe case of cholera morbus, for which it has frequently been mistaken. As a rule, the symptoms are continuous, although there are occasionally remissions and even intermissions. Coma, paralysis, and convulsions may supervene before death. The urine is often partially suppressed. If the patient recovers from the immediate attack, he may suffer for a long time after from indigestion, partial paralysis, or from epilepsy.

Certain anomalies may occur. The pain may be absent or slight. Occasionally, there is a remarkable absence of symptoms. Vomiting and purging and thirst may not be present. Some cases especially resemble cholera morbus from the intensity of the gastro-enteric irritability, while others indicate severe nervous disturbance by the intense headache, giddiness, restlessness, violent cramps, delirium,

convulsions, and coma. Again, there may be immediate collapse, little or no pain, vomiting, or purging, but a cold, clammy skin, extreme prostration, very frequent and feeble pulse, slight coma, with perhaps convulsions and death within a few hours after swallowing the poison. In yet other instances the symptoms resemble those of narcotics, the person falling into a profound sleep, deepening into coma, and dying in a few hours without rallying. In the latter cases the autopsy has frequently shown absence of inflammation of the stomach.

All the above varieties of symptoms occur quite independently of the size of the dose or mode of administration, and they cannot be satisfactorily explained except by referring them to constitutional peculiarities.

The symptoms of chronic poisoning usually result from small doses of arsenic frequently repeated, or from exposure to the vapors of arsenical products, as in the case of workmen, or from the accidental inhalation of arsenical dust from wall papers. The eyes and nasal mucous membrane become inflamed and watery, there is great gastric distress, with frequent sickness and vomiting, diarrhea, headache, and giddiness, a jaundiced skin, an eczematous eruption, local paralysis, general emaciation, falling out of the hair, salivation and excoriation of the tongue with hemorrhage; and death may occur from exhaustion. The symptoms in such a case are frequently very obscure and misleading, and perhaps chance alone may reveal the real source of the disorder.

The time when the symptoms appear varies considerably. As before stated, these do not generally manifest themselves for a half hour or an hour after swallowing the poison; but there are numerous exceptions. Cases are recorded in

which it is claimed they appeared in the act of swallowing, but this seems incredible; others, in which they were exhibited in eight, ten, and fifteen minutes after. On the other hand, numerous instances are recorded where the time was protracted for many hours. A case has been reported in which the symptoms were delayed for sixteen hours after a dose of a drachm of the poison. These discrepancies may, in part, be accounted for by the stomach being empty or full at the time of administration; also by the form of the dose, whether liquid or solid; by the time of day, whether before going to sleep, or otherwise. The simultaneous use of opium or alcohol would, no doubt, exercise a modifying influence over this poison.

The external application of arsenic, either to the sound skin or still more to abraded or ulcerated surfaces, is often followed by fatal results. Proofs of this are exhibited in the effects of the applications of cancer cures to ulcerated breasts; also in the use of arsenical solutions to the sore heads of children. In some of these instances absorbed arsenic has been detected after death in the viscera of the body. Arsenic has also proved fatal when injected into the rectum and vagina.

In all of the above cases of the external application of this poison, its usual constitutional effects were produced, such as burning and constriction of the throat, thirst, vomiting and purging, great depression, and the various nervous disturbances above described.

Fatal Dose.—*Two grains* may be considered the minimum fatal dose for an adult, although some of the cases on which this limit is based are of doubtful value. Smaller quantities than two grains have produced alarming symptoms. On the other hand, recoveries have often

occurred after very large doses—one to two ounces—have been swallowed.

Fatal Period.—The great majority of deaths occur within twenty-four hours, and of these the most within eight or ten hours. The shortest period is recorded by Taylor, of a youth, aged seventeen years, who died in twenty minutes from the effects of a large dose accidentally swallowed; the symptoms were of a tetanic character. Other cases are reported where death occurred in two or three hours. On the other hand, life may be prolonged for weeks, months, or even years, the patient suffering greatly during the interval.

Arsenic is not a strongly cumulative poison; it is temporarily deposited in the liver and other organs of the body, after absorption, but it is rapidly eliminated from the system by the urine, bile, and other secretions. Should the person survive for two or three weeks, no trace of the poison may be found after his death, in consequence of its total elimination during the interim. The exact period at which arsenic is completely eliminated from the human system is not fixed; but the analyst need hardly expect to discover it after sixteen days, although it has been detected in the urine of a man twenty-four days after swallowing a large dose, and who subsequently recovered.

The rapidity with which it is absorbed and deposited in the tissues is very great. Taylor found it in the human liver four hours after it had been swallowed, though doubtless it reaches this organ much sooner. He believes that the liver acquires its maximum of absorbed arsenic (about two grains) in fifteen hours, after which the quantity gradually diminishes.

The question of the elimination of arsenic from the human system may have an important bearing, as in a case

in which a person who has been taking small doses of arsenic, medicinally, for a length of time, should suddenly die from gastro-enteritis, and a post-mortem examination should reveal the presence of absorbed arsenic in the organs. Here both the symptoms and the chemical analysis would strongly confirm the suspicion of arsenical poisoning, unless the fact of the medicinal administration of the drug could be satisfactorily established.

Arsenic is known to be deposited in all the tissues of the body except the hair.

Post-mortem Appearances.—The most decided evidences of the irritant character of the poison are exhibited by the stomach, the mucous lining of which is usually highly inflamed, sometimes presenting a uniform, deep-red color, at others, showing patches of diffused dark redness. Arsenic seems to have a specific effect on the stomach, no matter by what avenue it is introduced into the system. Occasionally, the lining membrane is thickened and corrugated ; again, it is softened and readily separated. When the poison has been taken in substance, it is not unusual to find patches several inches in extent, consisting of tough, yellowish-white masses of arsenous oxid, mixed with lymph and mucus, firmly adherent to the membrane, and forming so many foci of intense inflammation. White spots of arsenous oxid are often found between the rugæ, and when a long interval has occurred before the examination, yellow stains may be found, as the result of a decomposition into the yellow sulphid.

Ulceration of the stomach is rare ; but Dr. Reese witnessed two instances. In one, death occurred in eight hours after swallowing the poison. In the other case the examination was not made until four months after death ; here, the

ulcer was a quarter of an inch in diameter, and was surrounded by a deep zone of dark, effused blood, and had penetrated down to the peritoneal coat of the stomach. Perforation is still more rare.

The upper portion of the small intestines is very apt to be involved in the inflammation ; also the cecum and rectum. Other organs, as the lungs, brain, and bladder, are occasionally found congested ; but these offer no diagnostic points. The most remarkable fact connected with the post-mortem appearances is the occasional absence of all signs of inflammation, even in cases where there had been violent inflammatory symptoms before death.

An important circumstance is the antiseptic power of arsenic, which accounts for the remarkable preservation of the body for many months after death, whereby the detection of the poison is possible for a long period after burial —in one case fourteen years after death. Of course, after such an interval most of the body would be decomposed ; but still enough remains for the purpose of identification. In such cases there is generally noticed an absence of the usual cadaveric odor, and also the presence of numerous yellow patches over the abdominal viscera, due to the production of the yellow sulphid, by the action of hydrogen sulphid on the arsenous oxid.

It should, however, be stated that arsenic does not uniformly exert this preservative power on a dead body ; in fact, in some cases it would seem that putrefaction has advanced with increased rapidity. These instances, however, are exceptional ; but they should put the expert on his guard against too positive an assertion as to the presence of arsenic when a body exhibits an unusual degree of preservation, since this may be due to other causes.

Treatment.—Vomiting should be promoted, but only by the mildest means; the stomach-pump may be employed, if on hand; warm diluent drinks are useful; after this, the free use of freshly prepared ferric hydroxid. This can be prepared extemporaneously by treating a solution of any red salt of iron with any alkali, alkaline carbonate, or magnesia. Ferric chlorid and ferric subsulphate are common compounds suitable for the purpose. The precipitate should be collected on a strainer, *e. g.*, a piece of muslin or linen washed two or three times with water and administered freely, best in milk or other demulcent liquid. Afterward a dose of castor oil should be given.

There are numerous attestations to the value of this antidote; it acts by converting the poison into an insoluble compound. Freshly precipitated magnesium hydroxid is also recommended as an antidote.

Ferrous hydroxid obtained by adding an alkali to a solution of ferrous sulphate (green vitriol or copperas) is not considered an antidote, but it may be promptly converted into ferric hydroxid by the addition of some hydrogen dioxid. The change is indicated by the conversion of the green precipitate into a red one.

Analytic Methods. Sublimation Tests.—(1) A small quantity of the white powder placed on platinum foil and heated is entirely dissipated in white inodorous fumes; (2) slowly heated in a narrow glass tube, it sublimes, forming a white ring of octahedral crystals on the cool portion of the tube visible by a good magnifier. Calomel and corrosive sublimate will each form white rings under similar conditions; the arsenic deposit is distinguished from these by being in octahedral crystals; by the action of sodium hydroxid solution which dissolves it without color, while

it gives a black precipitate with calomel, and a yellowish with corrosive sublimate; (3) moistened with ammonium sulphid, and evaporating, it produces the yellow sulphid; (4) put into a reduction tube along with some reducing agent, as charcoal, black flux, or six or eight times its volume of dried potassium ferrocyanid, and heated by the flame of a spirit-lamp, it is reduced, and the metal is volatilized, and collects on the cool part of the tube in the form of a brilliant steel-gray ring, or mirror. A distinct odor, recalling that of garlic, is produced in this form of the test.

In order to effect the sublimation and reduction successfully, the reduction tube should be small—about the eighth of an inch in diameter, and three inches long, and it should be clean and free from moisture. The reducing agent should be dry and thoroughly mixed with the arsenous oxid. After it is introduced the tube should be wiped out with a wad of cotton or a roll of filtering paper. The tube should first be gently warmed just above the contents, and then the lower portion fully heated in the flame. This precaution insures a better formed metallic ring.

For the sublimation simply, the above process is to be pursued, with the omission of the reducing agent.

The obtaining the metallic ring, or mirror, by the reducing process, may be regarded as positive proof of the presence of arsenic; but in a medico-legal case this should be confirmed by further proofs: (1) the arsenic mirror is wholly soluble in sodium hypochlorite; (2) it is soluble in hot nitric acid, and the solution, on evaporation, leaves a brick-red deposit when touched with silver nitrate solution, due to the formation of silver arsenite; (3) if the closed end of the tube be broken off and heat applied to the sublimate, it will readily volatilize, and, combining with the oxygen of

the air, will condense on the upper portion of the tube in a white ring of arsenous oxid ; (4) this latter may be dissolved in a few drops of warm water and subjected to the liquid tests.

The Liquid Tests.—These are ammonio-copper sulphate and ammonio-silver nitrate. They should be prepared only when required for use. The former is made by the cautious addition of ammonium hydroxid to a somewhat dilute solution of copper sulphate, until the precipitate is barely redissolved. When this reagent is added to a solution of arsenous oxid, it throws down light-green copper arsenite. This precipitate is soluble in ammonium hydroxid and in free acids. If the arsenic is in very minute quantities, the characteristic color does not appear immediately, but is deposited on standing.

The silver test is prepared by adding ammonium hydroxid to a strong solution of silver nitrate, until the precipitate is barely redissolved. When this is added to the arsenical solution, a canary-yellow precipitate of silver arsenite occurs, which is freely soluble in alkalies and acids.

These liquid tests are available only in perfectly pure solutions of arsenous oxid ; they are inadmissible in the presence of organic matter, since various organic substances will produce similar colors. They may, however, be satisfactorily confirmed, (1) by heating either of the dried precipitates (copper or silver arsenites), either alone or with a reducing agent, in a reduction tube ; the former experiment will yield a sublimate of octahedral crystals, the latter the metallic mirror. (2) If the solution of copper arsenite in ammonium hydroxid be poured over a crystal of silver nitrate, a film of yellow silver arsenite is immediately formed around it.

The Hydrogen Sulphid Test.—This consists in passing washed hydrogen sulphid gas through the solution, slightly acidified by hydrochloric acid ; a clear yellow precipitate falls—arsenous sulphid, soluble in the alkalies and insoluble in acids. In very dilute solutions, the precipitate may not separate until the excess of the gas is driven off by heat.

Fallacies.—Cadmium, tin, and selenium yield somewhat similar precipitates. Practically, the only one that need be considered is cadmium, which, however, is easily distinguished, as follows : (1) The arsenous sulphid is soluble in ammonium hydroxid and insoluble in the acids ; with cadmium sulphid it is precisely the reverse ; (2) when dried and sublimed with a reducing agent, the arsenous sulphid yields a metallic ring ; the cadmium, a brown oxid.

The arsenous sulphid may be proved by (1) obtaining the metallic ring by subliming with a reducing agent ; (2) by boiling the sulphid in hydrochloric acid, along with a piece of bright copper foil ; a steel-gray deposit shows the presence of arsenic ; (3) by dissolving it in boiling nitric acid, cautiously evaporating to dryness, and adding a few drops of strong silver nitrate solution, a brick-red silver arsenate will be produced.

Marsh's Test.—The principle here involved is that when arsenic comes in contact with nascent hydrogen, it combines with it to form hydrogen arsenid (arsin), a gas which possesses peculiar properties, by means of which the arsenic may be recognized with great certainty. The simplest method is to add to the materials for generating hydrogen (zinc, water, and sulphuric acid), in a wide-mouth flask, the suspected arsenical solution. The cork fitted to the mouth of the flask should have two perforations, through

one of which a perpendicular, funnel-shaped glass tube passes down below the surface of the liquid contents; through the other aperture a tube, bent at right angles, is inserted, out of which the generated gas issues. A drying tube (containing fragments of fused calcium chlorid, or of pumice stone moistened with sulphuric acid) is fastened by one end to the exit-tube, and by the other extremity to a horizontal tube of hard German glass, about a foot long, which may be turned up at the furthest end, and made to terminate in a small point, for burning the gas in a jet as it escapes.

In performing this experiment certain precautions are necessary. In the first place, the absolute purity of the zinc and sulphuric acid must be secured. The acid should be diluted with two or three times its volume of water before being added to the zinc mixture. Secondly, caution should be exercised to have the atmospheric air completely expelled from the apparatus before lighting the jet, otherwise the mixture of hydrogen and air will produce a violent explosion. The evolution of the hydrogen should be rather slow. After waiting the proper time, the jet may be lighted; it will burn, if pure, with a nearly colorless flame, though it is usually yellowish from the sodium of the glass point. The purity of the materials may now be tested by applying the flame of a large spirit-lamp or a Bunsen burner to the horizontal glass tube until it is red-hot; if no stain or deposit occurs just beyond the heated spot, the absence of arsenic is certain; or if no deposit forms on a piece of white porcelain held over the burning jet, the same conclusion may be held.

A small quantity of the suspected solution is now to be introduced through the upright tube; action immediately

commences, producing hydrogen arsenid, which has the following characteristic properties:

As soon as the arsenic combines with the hydrogen, an immediate change occurs in the appearance of the flame, which increases in size and acquires a faint bluish color; and unless the arsenic be in minute quantity it evolves white fumes and gives out a garlicky odor. If these fumes are received into a short, wide glass tube, they will condense into a white powder, sometimes crystalline, and may be identified as arsenous oxid.

If the jet be made to impinge on a piece of glass or white porcelain, held horizontally and just within the flame, a deposit of pure arsenic, of a brilliant steel-gray or brownish-gray color, occurs, which may be multiplied by changing the position of the porcelain. In order to procure the finest deposits the flame should be steady and not too large. Although these spots may vary somewhat in color, they are always brilliant and never sooty.

These deposits may be identified (1) by their immediate solubility in sodium hypochlorite; stains of antimony, which they most resemble, are not thus affected. (2) When touched by a drop of ammonium sulphid, they do not immediately disappear; antimony stains are instantly dissolved. (3) Both stains are attacked by hot nitric acid, and on evaporation yield white residues; if now touched with a drop of strong solution of silver nitrate, the arsenic spot assumes a brick-red color, while the antimony stain remains unaffected.

On placing the flame of a large spirit-lamp or a Bunsen burner immediately below the horizontal tube (which should have been previously contracted in several places), a deposit of metallic arsenic forms just in advance of the flame, which

should be held a little behind one of the contracted spaces; the deposit continues to increase until it may completely occupy the whole of the narrow space, and even advance beyond it. This constitutes the arsenical mirror. It may have the steel-gray, brilliant appearance already described, or even a coppery hue, and it is highly characteristic of the presence of arsenic. Several such mirrors may thus be obtained by moving the flame to different parts of the horizontal tube, provided there is a sufficient amount of the material present. The tube may afterward be broken across, so as to separate the mirrors, which may be retained for exhibition or for other tests.

This mode of experimenting yields even more delicate results than the jet; but unless the quantity of arsenic is extremely small, it will always be possible to obtain both results by Marsh's process.

One fallacy only may interfere with this experiment—the presence of antimony, which in contact with hydrogen yields a gas very similar to hydrogen arsenid, and, like the latter, is decomposed by heat, yielding a metallic deposit. They may be distinguished as follows: The antimony mirror is deposited just over the heated spot and not in advance of it; it has usually a darker appearance than the arsenical mirror; the latter is more easily volatilized than the former and condenses higher up in the tube in octahedral crystals. The two deposits may also be tested by the different reagents mentioned above; also by dry hydrogen sulphid, which produces, with the arsenical gas, a yellow deposit, and with the antimonial gas an orange-red.

If the hydrogen arsenid be passed through a solution of silver nitrate, a black precipitate of metallic silver is formed, arsenous oxid remaining in the solution. The

filtered solution will contain, also, free nitric acid and any excess of silver nitrate. On neutralizing with ammonium hydroxid a yellow precipitate will fall—silver arsenite. The analyst should not rely on the mere production of the black color, since other gases besides hydrogen arsenid might cause this; but he should continue the experiment as above described.

Bloxam's Method.—The principle of this is the same as that in Marsh's process—the action on nascent hydrogen; but an electric current is employed to decompose the water instead of zinc. It is a delicate and satisfactory modification; but it should be remembered that the arsenic should be present in the form of arsenous oxid.

Reinsch's Test.—This consists in producing a deposit of copper arsenid on bright copper foil. The suspected solution, acidulated with about one-sixth of its bulk of pure hydrochloric acid, is first brought to the boiling-point, and a piece of bright copper foil is introduced and the boiling continued. The presence of even a very minute quantity of arsenic is soon indicated by the tarnishing of the copper, which ultimately assumes a dark steel-gray or even black color. If the quantity of arsenic be large, the deposit is immediate and very dark; it may even break off in scales; if the amount is very small, the stain upon the copper will be fainter and merely of a violet or bluish tint. Moreover, the deposit on the copper is affected by the degree of dilution; hence, if the quantity of the water be large, it should be reduced by evaporation, as it may require boiling for half an hour before a visible deposit occurs.

This reaction is very delicate and extremely satisfactory, and commends itself by its simplicity. One great advan-

tage that it possesses over the other tests is that it may be practised in complex organic fluids; hence, it is often employed as a trial test.

Certain precautions are, however, required in employing it. First, the purity of the hydrochloric acid must be insured; this is easily accomplished by first boiling some of the acid diluted with water and then introducing a slip of the copper. If no stain appears upon the latter after a few minutes, we may be certain of the absence of arsenic or antimony. Secondly, the copper must be both bright and pure. Its brightness is effected by rubbing it with emery paper, and it may be regarded as pure if, when boiled in the acid arsenical liquid, it is not dissolved and does not impart a green color to the liquid. Copper and pure hydrochloric acid adapted to use in these tests can now be easily obtained from dealers.

In applying this test it is best to use small pieces of copper successively, removing each fragment as it becomes coated. By this means the whole of the arsenic may be removed from the solution. One grain of arsenous oxid dissolved in the acid solution and treated by Reinsch's process will impart a distinct, dark, steel-gray coating to at least four hundred square inches of copper surface. This method will, therefore, serve for an approximative quantitative estimate of the poison. When it is in the form of arsenic acid, the solution is required to be much stronger for this test.

Another caution to be observed is not to remove the copper too soon from the liquid, in case no deposit occurs; in doubtful cases, the boiling should be continued for at least ten minutes. If the copper be kept in for an hour or

longer it may acquire a dark film, especially in the presence of organic matter, even in the absence of arsenic.

Fallacies.—Other substances—antimony, mercury, silver, bismuth, tin, gold, platinum, and palladium ; likewise organic matter, especially if it contain sulphur—will impart a dark coating to copper in Reinsch's process ; hence, corroborative proof is required. This is afforded by washing a fragment or two of the coated copper in distilled water, and then thoroughly drying them between the folds of filtering paper (avoiding touching with soiled fingers), and rolling them up into small coils, and then introducing one or more of them into a small, clean reduction tube, and applying the heat of a spirit-lamp. The arsenic will volatilize and condense in the cool part of the tube, in a white ring of octahedral crystals. The only other metals which could volatilize under such circumstances are antimony and mercury ; but the sublimate from antimony is either amorphous, or else in fine, acicular crystals, while the mercurial deposit consists of fine, spherical globules of the metal, easily recognized by a magnifier.

The attention of the toxicologist should especially be directed to the fact that if copper be boiled for some time in an acid solution of complex organic matters, especially containing sulphur, it will become coated with a decided dark stain, and will, moreover, yield, when heated in a reduction tube, an amorphous sublimate, which may even sometimes show acicular crystals, consisting apparently of a compound of copper. This sublimate deposits very near the copper, and will not re-sublimate. Hence, it follows that, for the complete corroboration of Reinsch's test for arsenic, nothing short of the production of the octahedral crystals and their subsequent identification will suffice. Wormley

has observed that an antimonial deposit from the copper may occasionally contain octahedral crystals, which are found lower down in the deposit.

It must also be remembered that the presence of certain substances in the arsenical solution may prevent the deposit of this metal upon the copper—viz., a chlorate or other oxidizing agents. Consequently, Reinsch's test is not applicable to a solution obtained by boiling viscera in hydrochloric acid and potassium chlorate.

Bettendorf's Test.—A saturated solution of stannous chlorid in concentrated hydrochloric acid produces with arsenical compounds a brownish or grayish precipitate of free arsenic. The introduction of a small piece of tin foil is an advantage in some cases, but this must not be done when bismuth, antimony, or other easily reducible substance is present. The application of a moderate heat is advisable.

Toxicologic Examination.—The analyst should always first search for particles of solid arsenous oxid in the stomach and the vomited matter, and carefully remove these for examination. Organic mixtures should be diluted, if necessary, with distilled water, and acidified with about one-sixth part of hydrochloric acid, and boiled gently for about fifteen minutes; when cooled, the mixture should be strained and concentrated by evaporation over a water-bath. A portion may now be subjected to a trial test by Reinsch's process; if no deposit takes place after boiling for half an hour, it is safe to conclude that no arsenic is present. If deemed advisable, another portion of the filtrate may be subjected to the action of hydrogen sulphid. It is not yet fitted for Marsh's process, owing to the large amount of organic matter present, which causes much frothing.

Stomach and Contents.—The organ should first be carefully examined as to its pathologic condition, and also for the presence of solid particles of the poison. It should then be cut up into small fragments with scissors known to be perfectly clean, and, together with its contents, placed in a clean porcelain evaporating dish; distilled water added in sufficient quantity, together with about one-sixth the bulk of pure hydrochloric acid, and heated gently for about an hour, when most of the solid portions will have become disintegrated. After cooling, the mixture is thrown upon a muslin strainer and the solid matters washed several times with pure warm water and squeezed. The strainer and contents should be preserved for subsequent examination. The filtrate should be concentrated by evaporation over a water bath and then filtered through paper.

Reinsch's process may now be applied as a trial test to a portion of the liquid. If no result is afforded after a sufficient boiling, another portion may be tried by hydrogen sulphid; and if these give negative results, the absence of arsenic may be regarded as established. Marsh's process is inadmissible here for the reason just stated.

But if the presence of the poison is revealed by the trial test, a given portion of the liquid may be completely exhausted by Reinsch's process and the balance treated with hydrogen sulphid for several hours, until all the arsenic is precipitated. This process is facilitated by gently warming the liquid. The resulting precipitate will have a dirty yellowish color,—not the bright yellow seen when the arsenous oxid is pure,—and will contain both organic matter and reduced sulphur in greater or less amounts.

The mere production of such a precipitate is not sufficient of itself to establish the presence of arsenic, since it

is known that in an acid, complex, organic solution, associated with coloring matter, hydrogen sulphid will throw down a precipitate very much resembling an impure arsenous or antimony sulphid, but consisting only of organic matter and free sulphur; hence, a further examination is required to verify this suspected sulphid.

The precipitate should be washed carefully on a filter and digested with pure ammonium hydroxid, which will dissolve out all the arsenous sulphid together with some organic matter. The solution is filtered and carefully evaporated to dryness. If much arsenous sulphid is present it will have a decided yellow color. When perfectly dried it should be verified by the methods described above. If, however, only a minute quantity be present, the dried residue will have a brown color and must be purified as follows: It is placed in a porcelain capsule, a little concentrated nitric acid added, and the mixture evaporated to dryness over a water-bath, the addition of acid being repeated until the moist residue has a yellow color. It is next moistened with a few drops of solution of sodium hydroxid, together with a little pure sodium carbonate and sodium nitrate, well stirred, and cautiously evaporated to dryness. The heat is now gradually increased until the mass becomes colorless, when the organic matter may be considered completely destroyed. The cooled mass consists of a mixture of the sodium arsenate with sodium nitrate and nitrite. It should be dissolved in warm water, and after filtration should be acidulated with pure sulphuric acid and evaporated till dense white fumes appear. By this treatment the residue is reduced to a mixture of the sodium arsenate and sodium sulphate. A portion of this solution may now be tested in a Marsh apparatus; another

given portion by hydrogen sulphid for quantitative determination, the arsenic acid being first reduced to arsenous by sulphurous acid or sodium sulphite.

Separation of Absorbed Arsenic from the Tissues.—It is indispensable in such investigations to examine for absorbed arsenic in the different viscera, as the liver, kidneys, spleen, etc., inasmuch as its detection in the organs is evidence that the poison had been actually taken during life, provided always that post-mortem imbibition can be excluded. Besides, it may happen that, if the quantity swallowed has been only just sufficient to have caused death, the whole of it may have disappeared from the stomach by absorption and can only be discovered in the organs. The brain should likewise always be examined.

Several methods are described for this sort of research, all having reference to one common end—the destruction of organic matters. Very often satisfactory results can be obtained by simply boiling the finely divided tissue in water and hydrochloric acid and applying Reinsch's test.

Method of Fresenius and Babo.—The solid matters (as about one-fourth of the liver) should be finely divided, pressed in a mortar, and pure water added to bring it to the consistence of thin gruel. The whole should then be digested in a porcelain dish over a water-bath with pure hydrochloric acid about equal in weight to the dry material. Small quantities of powdered potassium chlorate are from time to time added to the hot liquid, when effervescence will occur with escape of chlorin gas. In a short time the solid matters will disappear and the liquid will acquire a clear yellow color. The heat should be continued until

all odor of chlorin has disappeared. When the liquid has cooled it should be properly strained. Any arsenic present will now exist in the form of arsenic acid.

A portion of this liquid may be tested in a Marsh apparatus. But for the other tests it is necessary that the arsenic acid should be reduced to the lower oxid—arsenous. This is effected by adding sodium sulphite to the solution and heating it until all odor of sulphurous acid has disappeared. It is now allowed to stand for several hours and any deposit removed by filtration. The resulting solution, after proper evaporation over a warm bath, may be examined by hydrogen sulphid, but not by Reinsch's process, for the reason above given.

Method of Danger and Flandin.—The organs, properly divided, are introduced into a glass retort, together with one-fourth their weight of strong sulphuric acid, and heated on a sand-bath until the whole is thoroughly carbonized and dried. After cooling, the mass is removed and powdered. The powder is moistened in a porcelain capsule, with one-tenth of its weight of pure nitric acid, and heated on a water-bath for half an hour. This converts the arsenic into arsenic acid. Warm distilled water is now added and the matters filtered through paper. The filtrate is colorless, if pure; if colored, it must be evaporated to dryness, treated again with nitric acid and water, and filtered the second time. The acid liquid must next be evaporated to dryness, to get rid of the nitrous vapors. It should now be mixed with a sufficient quantity of water, when it will be fit for testing, as above described.

Method of Gautier consists of moderately heating the tissue or organs, finely divided, with about one-third its weight of pure nitric acid, on a porcelain dish. Now liquefaction ensues; pure sulphuric acid is now added (about one-sixth part of the nitric acid), when violent action ensues, and the mass assumes a brownish color. It is then heated till vapors of sulphuric acid appear. The whole is next treated with small portions of nitric acid, successively added, which causes the mass to liquefy, with the escape of nitrous fumes. It is next heated until it is carbonized. It is then pulverized, and exhausted with boiling water, and filtered. The solution containing arsenic acid is next treated with sodium sulphite, and precipitated with hydrogen sulphid.

Distillation Process.—The tissue should first be thoroughly dried over a water-bath, and then mixed with about its own weight of pure hydrochloric acid, and distilled in a retort over a sand-bath almost to dryness, the distillate being received into a small quantity of water properly refrigerated. By this process the arsenic is separated as arsenous chlorid. It possesses the advantage of immediately separating the arsenic, in a tolerably pure state, from the tissues. The distillate may be subjected to all the usual tests.

The urine can be examined by Reinsch's test, by first concentrating by evaporation; or it may be evaporated to dryness, and then treated with hydrochloric acid and potassium chlorate, and examined in the usual way.

Arsenic is not a normal constituent of the human body. Neither has it been found in the soil of cemeteries in a soluble state; consequently, there need be no apprehension

of a dead body ever imbibing this poison from the surrounding earth.

Solutions of arsenical compounds often mixed with zinc chlorid are now used by undertakers as embalming fluid.

Arsenic is estimated quantitatively as a sulphid; 100 grains of pure dried sulphid represent 80.48 of arsenous oxid.

Fowler's Solution.—This preparation, much used in medicine, is made by dissolving arsenous oxid in potassium carbonate and tincture of lavender. It contains four grains of arsenous oxid to the fluid ounce.

Arsenic Acid.—A powerful poison, but not often employed as such. It is tested as arsenous oxid; with hydrogen sulphid it yields a yellow precipitate after a considerable time. The most delicate test is silver nitrate, which yields a brownish-red precipitate (silver arsenate).

Silliman has given an account of the death of a boy, between three and four years of age, from sodium arsenate, a poisonous preparation sold in New York under the name of "pest poison," for destroying potato bugs. The most singular circumstance connected with the case was the entire absence of all the usual symptoms of arsenic poisoning, such as pain, vomiting and purging, etc., but, on the contrary, those of a powerful narcotic, like belladonna or stramonium. There were profound stupor, dilatation of the pupils, a rapid pulse, and hurried respiration. After partial recovery a relapse took place, the child dying, apparently from asphyxia, about nine hours after swallowing the poison.

Copper Arsenite—*Scheele's Green.*—A fine green powder, insoluble in water, but soluble in acids and alkalies. By sublimation in a reduction-tube it yields crystals of arsenous oxid.

Copper Aceto-arsenite—*Schweinfurth* or *Brunswick Green*—*Vienna* or *Emerald Green*—*Paris Green.*—A pigment sometimes used for staining wall paper, bon-bon paper, toys, articles of dress, artificial flowers, and millinery. Under the name of Paris Green it has lately become the frequent cause of deaths, both homicidal and suicidal. It is readily identified by heating it in a test-tube, when it gives off fumes of acetic acid, deposits crystals of arsenous oxid, and leaves a residue of oxid of copper.

Paper and other articles colored with this pigment may be easily tested by dipping them into a weak solution of ammonium hydroxid, when they will be speedily bleached, while the solution will become blue. If now a crystal of silver nitrate be placed in the latter, a film of yellow is immediately formed around it—silver arsenite. A drop of ammonium hydroxid applied to paper colored by this pigment immediately turns it blue.

Chronic arsenical poisoning is a frequent result of living in rooms the walls of which are covered with paper colored with arsenical colors; the fine powder or dust detached from the walls is inhaled into the lungs, and produces the symptoms above described.

Sulphids.—Two sulphids are found as minerals, the yellow arsenous sulphid (orpiment), and the red arsenous disulphid (realgar). Arsenous sulphid is sometimes taken as a poison. They are both soluble in alkalies, and when

mixed with a strong reducing agent and sublimed, they yield metallic mirrors.

Hydrogen Arsenid.—This is a gaseous body of highly poisonous character, which is readily produced by the action of nascent hydrogen on arsenical compounds. It is not infrequently found as an impurity in hydrogen obtained by the solution of zinc in sulphuric acid. Cases of poisoning by it occur among chemists and among operators engaged in chemical industries. The principal symptoms are: headache, severe lumbar and abdominal pain, vomiting, thirst, suppression of urine, and bloody urine. The cases are usually fatal though often prolonged. No special antidote is known.

ANTIMONY COMPOUNDS.

Tartar Emetic is the only preparation of **Antimony** of much medico-legal importance; but the *chlorid* is occasionally a cause of poisoning.

Tartar Emetic (*tartarized antimony; stibiated tartar, antimony potassium tartrate*).—This body is of rather peculiar composition. It is formed from tartaric acid by replacing one of the hydrogen atoms by potassium and another by antimony monoxid, a radicle. The proper name would be potassium antimonoxyl tartrate. It occurs in large, colorless crystals and as a white powder. The commercial salt sometimes contains traces of arsenic. Heated in a reduction-tube it blackens, and is reduced to a mixture of carbon and antimony. Heated on charcoal, before the blowpipe, it is also reduced, yielding globules of antimony, along with a white incrustation of the oxid. It is soluble

in three parts of boiling and fifteen of cold water ; its solution slowly undergoes decomposition. It is insoluble in alcohol. The taste is nauseous, metallic, and acrid.

Symptoms.—A harsh,metallic taste is perceived on swallowing, soon followed by nausea, retching, violent and incessant vomiting, great thirst, constriction of the throat, burning pain in the stomach and abdomen, and profuse purging of a watery character ; sometimes blood is found in the discharges both from the stomach and bowels ; severe cramps in the extremities, a very feeble, rapid pulse, profuse perspiration, extreme prostration, with a disposition to syncope. The urine is generally increased in quantity, but is voided with pain ; at times there may be delirium and convulsions preceding death. In exceptional cases, there is an absence of vomiting and purging, the symptoms being those of extreme collapse, with a cold, clammy sweat, feeble respiration, irregular pulse, delirium, unconsciousness, and tetanic convulsions.

An occasional symptom is noted if the patient survives three or four days : a pustular eruption over the body, similar to that produced by the external application of the substance.

In some instances it appears to exert a slightly corrosive impression, causing aphthous ulceration of the tongue and inside of the mouth. While acting as an irritant to the gastro-enteric mucous membrane, it undoubtedly exerts a depressant effect upon the heart.

Fatal Dose.—This has not been precisely determined. In some cases, two or three grains have produced alarming and even fatal effects, whilst in others enormous doses, up to an ounce, have failed to destroy life. Large doses, by exciting speedy vomiting, generally relieve themselves.

Probably twenty to forty grains may be regarded as the usual minimum fatal dose for an adult.

Fatal Period.—From an hour up to several days. In an exceptional case related by Deutsch, a woman took by mistake a scruple of tartar emetic, and died one year afterward from the irritant effects on the alimentary canal.

Post-mortem Appearances.—The irritant effects of this poison are displayed upon the lining membrane of the stomach and bowels, which is deeply reddened, softened, and covered with a blackish, thick, and viscid secretion, sometimes streaked with blood. The throat, esophagus, stomach, and bowels also exhibit aphthous-looking spots, or excoriations, and occasionally true pustules may be seen scattered throughout the intestinal tract.

The liver is generally enlarged and softened, and seems to have undergone a fatty degeneration. It is stated that the natives of Brunswick feed their geese upon antimony oxid, for the purpose of fattening them by increasing the size of their livers. The lungs are often deeply congested, sometimes exhibiting a true apoplexy. The mucous lining of the windpipe and bronchi is uniformly reddened. The brain is generally congested, both in its membranes and substance, the latter presenting, when cut, numerous bloody points. The ventricles occasionally contain an excess of serum, and there may also be some submeningeal serous effusion. The heart exhibits nothing abnormal. According to some authorities the blood retains its fluidity.

Treatment.—Vomiting should be assisted by warm mucilaginous drinks, or the stomach-pump may be employed. The proper antidote is tannin, in the form of some astringent vegetable infusion, such as green tea or nutgalls. Afterward opium and stimulants will be necessary.

Chronic Poisoning.—This method of poisoning is believed to be somewhat frequent. The symptoms are a distressing nausea, with occasional vomiting, diarrhea with pasty stools, loss of appetite, emaciation, slimy tongue, feeble action of the heart, difficult breathing, a pale and anxious countenance, faintings with increased perspiration and urination.

External Application.—When applied to the skin, tartar emetic occasions deep pustulation; it is also readily absorbed, especially from abraded surfaces, and produces all its constitutional effects the same as if swallowed, such as nausea, vomiting, debility, etc. Fatal effects have thus resulted, and the poison has been detected, after death, in the stomach, liver, kidneys, and other organs.

Analytic Methods.—1. *As a solid.*—Touched with a drop of ammonium sulphid, or a solution of hydrogen sulphid, it immediately acquires an orange-red color; this is characteristic of all the salts of antimony in their pure state. Heated in a reduction-tube, it blackens.

2. *In solution.*—(*a*) A drop of a strong solution, evaporated on glass, will exhibit the tetrahedral crystals; a weak solution gives a mass of confused crystals. (*b*) Either of the mineral acids dropped into it produces a white precipitate, soluble in an excess of the acid; this precipitate is also soluble in tartaric acid. (*c*) Acidulated with hydrochloric acid, and boiled on bright copper foil, the latter acquires a violet-colored deposit of antimony (Reinsch's test). (*d*) The above solution imparts a black stain to a strip of pure tin foil in the cold, whereby it is distinguished from arsenic. (*e*) Hydrogen sulphid or ammonium sulphid throws down from a pure solution a characteristic orange-red precipitate of antimonous sulphid. This precipitate is

soluble in sodium hydroxid, but scarcely so in ammonium hydroxid; insoluble in dilute hydrochloric acid; but if boiled in the concentrated acid, it is decomposed with the escape of hydrogen sulphid and the formation of antimonous chlorid. The resulting solution, if not too acid, when dropped into water immediately throws down a copious, white, flaky precipitate (the oxychlorid, or powder of Algaroth), which is quite characteristic. This may be identified (1) by its solubility in tartaric acid; (2) by touching it with ammonium sulphid, which imparts to it an orange-red color. The white precipitate obtained by dropping the bismuth nitrate into water is not soluble in tartaric acid, and is blackened by ammonium sulphid. (*f*) Galvanic Test.—This is made by placing a few drops of the solution, acidified by hydrochloric acid, upon a platinum capsule, and touching the latter, through the liquid, with a strip of bright zinc; metallic antimony is deposited on the platinum at the point of contact as a brownish or black film. The liquid should then be poured off and the platinum washed in distilled water. A small quantity of ammonium sulphid, poured upon the stain, speedily dissolves it (if antimony) by the aid of heat, and on evaporation an orange-red sulphid remains. A modification of this test may be advantageously applied for the detection of antimony in the organs.

(*h*) *Marsh's Test.*—If a solution of antimony compound be subjected to the action of nascent hydrogen, hydrogen antimonid (stibin) is generated in precisely the same manner as is hydrogen arsenid under the same conditions.

(1) If the gas is burned at the jet, it gives a bluish flame, evolving white fumes of antimonous oxid, and if these fumes are received into a short, wide test-tube, held just above

the flame, the white deposit of the oxid may be collected, which may be identified by ammonium sulphid. If a piece of cold, white porcelain be held horizontally just within the flame, the metal is deposited (as in the case of arsenic) in the form of a black, or nearly black, spot, which is usually surrounded by a grayish ring. These deposits may be multiplied by simply changing the position of the porcelain.

The only fallacy to which this test is liable is from arsenic, which, as has been shown, behaves in a somewhat similar manner. But they can readily be distinguished from one another by a little attention. The antimony deposit is, as a rule, blacker and less brilliant than that of arsenic; but if the spots of antimony are extremely small, this distinction is not so observable. Again, the antimony stains are more slowly dissipated by heat than with arsenic; the former immediately dissolve in a drop of ammonium sulphid, leaving on evaporation an orange-red deposit; the latter (arsenic) are slowly affected by it, and leave on evaporation a yellow residue. Furthermore, the arsenic deposit is immediately soluble in a solution of sodium hypochlorite, which has little or no effect upon the antimony stain. Nitric acid will also serve to distinguish them; both are dissolved by it, but on evaporation to dryness the arsenic residue gives to a solution of silver nitrate a brick-red color (silver arsenate), but the antimonial residue is not affected by it.

(2) If heat be applied to the horizontal tube in Marsh's apparatus, during the passage of the gas, decomposition takes place, as in the case of arsenic; but the deposition of the antimonial mirror occurs immediately over and around the heated portion, and not in advance of it. If the quan-

tity operated upon is very small, the deposit may take place wholly within the point of heat. These deposits exhibit the same chemical reactions as those produced on porcelain by the flame.

(3) If the hydrogen antimonid be passed into a solution of silver nitrate, the latter (as in the case of arsenic) becomes black, the whole of the antimony is precipitated as silver antimonid (with hydrogen arsenid, the precipitate consists of silver, arsenous oxid being in solution). This black precipitate should be collected on a filter, washed and boiled with dilute hydrochloric acid, which dissolves out the antimony and leaves the silver. On filtering the solution and treating it with hydrogen sulphid, the characteristic orange-red sulphid is precipitated.

Toxicologic Examination.—In certain cases it might be desirable to separate the tartar emetic, as such, from the stomach; this may sometimes be accomplished by dialysis. For all practical purposes it is deemed sufficient if the analyst can detect the antimony. The process of dialysis may also be employed to separate tartar emetic from food and vomited matters, but not, of course, for detecting absorbed antimony in the tissues.

The stomach, properly divided, and contents should be acidulated with tartaric acid, and gently heated with sufficient distilled water over a water-bath for about half an hour. When cold, the matters should be strained through muslin; the solid portions are to be washed and pressed, and the whole of the liquid carefully evaporated to about one-half. Trial tests may now be made on a portion of this liquid (*a*) by inserting a piece of pure tin foil in the cold; it will soon blacken if antimony is present; (*b*) acidulate with hydrochloric acid, boil and introduce a piece of bright

copper foil (Reinsch's test); it will speedily acquire a violet stain. (*c*) The remainder of the liquid, slightly warmed, should be treated with hydrogen sulphid for several hours; a dirty orange-red or brown precipitate will be thrown down, consisting of antimonous sulphid, organic matter, and reduced sulphur. The mere production of a reddish-brown deposit under these circumstances is not sufficient to establish the presence of the antimony; what has been said upon this point under the head of arsenic applies with equal force to antimony.

The impure, dark-colored precipitate should be washed, treated on a porcelain capsule with a little pure nitric acid, and carefully evaporated to dryness; the operation to be repeated until all the organic matter is destroyed. The residue is then moistened with potassium hydroxid heated moderately, and the mixture gradually fused. The cooled mass is stirred in a little water acidulated with tartaric acid, boiled and filtered. The solution should be colorless. This may then be employed for Marsh's method, or with hydrogen sulphid; in the latter case the precipitate ought to exhibit the characteristic pure orange-red color.

It may be remarked here that in every case of poisoning with antimony (as indeed with some other substances), the actual obtaining of the characteristic element as a specimen is usually insisted on as absolute and unequivocal proof; and this, too, in quantities sufficient to admit of its positive identification by all the recognized tests. This is not considered a mere arbitrary or capricious rule. The highest authorities, such as Orfila, Tardieu, and Taylor, sanction it. Besides, the extraction of the antimony is not difficult, *e. g.*, by tin foil, by galvanism, by Marsh's and Reinsch's processes, and by the blowpipe.

In the Organs and Tissues.—Most of the absorbed poison will be found in the liver and kidneys. A given portion of these organs, properly divided, should be boiled in water acidulated with about one-sixth of hydrochloric acid. After proper concentration, trial tests may be made with a strip of tin foil in the cold, and copper foil in the boiling solution. If any indications of antimony are given, Reinsch's process may be carried out by subjecting a number of pieces of copper to the boiling acid liquid. These should be thoroughly washed and dried between the folds of bibulous paper; then rolled up and introduced into glass reduction-tubes, and heated by the flame of a spirit-lamp; a white sublimate will be deposited on the cool portion of the tube, as in the case of arsenic; but it is either amorphous or else composed of very fine acicular crystals.

The true nature of this antimony deposit is best shown, according to Watson, by boiling the coated copper in a dilute solution of potassium hydroxid, the metal being occasionally withdrawn from the liquid and exposed to the air to favor oxidation, when, after a time, the whole of the antimony will be in solution. The copper strip should now be removed, the solution acidulated with hydrochloric acid, and hydrogen sulphid passed through the liquid, when the antimonic sulphid, mixed with antimonous sulphid and sulphur, will be thrown down as an orange-red precipitate. The whole of the antimony may be thus removed by employing successive strips of copper and subjecting them to the above treatment; or the acidulated mixture may be boiled with potassium chlorate and subsequently treated as in the case of arsenic.

The galvanic test may also be applied with great advantage to detect the presence of antimony in the tissues.

Taylor's plan is an excellent one: Coil a portion of pure zinc foil around a piece of clean platinum foil, and suspend them in the acid solution of the tissues, sufficiently dilute to prevent too violent an action on the zinc. The liquid should be warmed. Sooner or later, according to the quantity present, the platinum will be coated with an adhering black powder of antimony; or the solution, properly acidified, may be placed in a platinum dish and a zinc rod introduced; after a sufficient time the antimony will be deposited on the platinum. Wash the platinum foil, and digest it in strong nitric acid, which will dissolve off the antimony; remove the platinum and evaporate to dryness. Redissolve the residue in hydrochloric acid, dilute the solution, and treat with hydrogen sulphid, which will precipitate the pure sulphid; or the deposit on the platinum may be dissolved off by ammonium sulphid.

The absorbed antimony may also be extracted by means of potassium chlorate and hydrochloric acid. In this case, in the subsequent application of hydrogen sulphid, there is no occasion to employ sulphurous acid to effect a reduction to a lower oxid, as in the case of arsenic.

It has been ascertained that antimony may be eliminated through the glands of the stomach, even when introduced into the system by some other avenue—*e. g.*, by hydrogen antimonid through the lungs.

The *urine* should always be examined in cases of suspected antimonial poisoning. This secretion is very soon affected by antimony compounds, and it may contain traces of them for some time after their discontinuance. The urine should be evaporated nearly to dryness, when it may be examined either by Reinsch's test, by tin foil, by the galvanic test, by Marsh's process, by potassium chlorate

and hydrochloric acid with hydrogen sulphid, and by carbonizing with sulphuric acid.

Antimonous Chlorid (*Butter of Antimony*).—This is a strong, corrosive poison, and has proved fatal in a number of instances. The symptoms and post-mortem lesions resemble those of the corrosive acids rather than those produced by tartar emetic. When thrown into water, the oxychlorid is generated, and falls as a copious, white, flaky precipitate. This is soluble in tartaric acid, and is instantly colored orange-red when touched with ammonium sulphid. The clear liquid contains hydrochloric acid, as shown by silver nitrate, which precipitates silver chlorid.

Antimony is estimated quantitatively as an antimonous sulphid. Every 100 grains of pure antimonous sulphid are equivalent to 85.75 of the antimonous oxid or 192.19 of anhydrous tartar emetic.

MERCURY COMPOUNDS.

Mercury is not poisonous in the free state, unless very finely divided. It has been administered to relieve constipation. The vapor is poisonous, and as this may be given off even at ordinary temperatures, it happens that looking-glass platers, and barometer and thermometer makers are very liable to become poisoned by the fumes. Cases of this form of poisoning have occurred among makers of vacuum electric lamps, for which a mercurial pump is employed. The symptoms of this sort of poisoning may come on gradually or suddenly; they may or may not be accompanied with salivation. They are chiefly marked by the

production of tremors of the limbs and paralysis, indicating the action of the metal on the nerve-centres. The general condition thus induced is named mercurial tremors and shaking palsy. The upper extremities are usually first affected, and then, by degrees, all the muscles of the body. There is an unsteadiness in the arms and legs, so that the patient cannot grasp an object, nor walk firmly on the ground. In bad cases he can neither speak nor chew his food. If the disorder be not checked, it proceeds to a fatal termination, attended with a loss of memory, insomnia, and delirium. Another curious symptom, not generally recognized, but usually present, is a brittle state of the teeth, causing them to chip.

The proper prophylactic treatment in this affection consists in cleanliness and good ventilation, together with the free internal use of albumin in the form of white of eggs.

All the mercurial compounds are more or less poisonous, but the most important one is corrosive sublimate.

Corrosive Sublimate (*Mercuric Chlorid*). — Occurs either in heavy crystalline masses of prismatic crystals, or as a white powder. It has a powerful styptic, nauseous taste, and is soluble in about thirteen parts of cold and three of boiling water. Alcohol and ether still more freely dissolve it, and the latter has the power of abstracting it from its aqueous solution.

Symptoms.—These usually come on immediately after taking the poison. A strong metallic, styptic taste is perceived, with a sense of heat and choking in the throat. A fierce, burning pain is felt, extending from the mouth to the stomach; nausea, retching, and vomiting of stringy mucus, often tinged with blood; pain in the abdomen,

which usually is swollen and tender to the touch; severe purging, sometimes of bloody matters, accompanied with tenesmus, as in dysentery. The pulse is feeble, quick, and irregular; countenance flushed and swollen, though sometimes it is pale and anxious; the tongue is white and shriveled; skin cold and clammy; respiration difficult; intense thirst; urine scanty or suppressed; cramps of the extremities; stupor, fainting, convulsions, and death. Salivation is apt to appear on the second or third day, but it is not an invariable symptom in acute cases. In exceptional instances there has been an absence of abdominal pain, as also of vomiting and purging.

Poisoning from corrosive sublimate differs from arsenical poisoning: (1) The former poison has a very distinct acrid taste, while the latter is almost tasteless. (2) The symptoms of the former come on almost immediately after it is swallowed; those produced by the latter are generally postponed from half an hour to an hour. (3) The discharges from corrosive sublimate poisoning are more frequently bloody than those from arsenic.

The external application of corrosive sublimate has often been attended with fatal consequences, and both the symptoms and post-mortem lesions in such cases resemble those produced by swallowing the poison, such as vomiting, purging, suppression of urine, salivation, etc., injection of the stomach and kidneys, with ecchymoses throughout the intestines and bladder. Cases of this character, resulting fatally, are reported where a solution of corrosive sublimate was applied to the scalps of children, for the cure of porrigo and ringworm. The recent antiseptic use of the dilute solution, by the surgeon, has occasionally produced poisonous results.

Fatal Dose.—The minimum fatal dose for an adult may be considered to be three grains, although, as in the case of other mineral poisons, very large quantities have been taken with impunity, having been speedily vomited or promptly neutralized by proper antidotes.

Fatal Period.—Taylor reports the shortest period on record, where death occurred in half an hour from an unknown quantity of the poison. In the majority of cases life is prolonged for several days—from one to five. In a summary of cases given by Guy, about half the number died in less than twelve hours, and the remaining half in a period varying from three to eleven days. More than one-half of the cases terminate fatally.

Treatment.—Promote vomiting by the free use of warm diluent drinks. The proper antidote is albumen, as found in eggs. This decomposes the mercurial salt, forming an insoluble albuminate; a large excess of albumin will redissolve the precipitate. The white of one egg is supposed to be capable of neutralizing four grains of corrosive sublimate. In the absence of eggs, glutin or wheat flour, in the form of paste, may be freely exhibited. Milk may also be freely used.

Post-mortem Appearances.—These are generally confined, as in the case of arsenic, to the mucous membrane of the stomach and bowels; but the corrosive action of the mercurial is more marked. The stomach, together with the mouth, throat, and esophagus, is often softened, of a white or grayish color, and corroded. The intestines, especially the cecum, often exhibit similar appearances. Perforation of the stomach is rare. The kidneys and bladder are usually highly inflamed, the former especially congested about the Malpighian bodies, and the epithelial cells deformed, gran-

ular, and partially destroyed. The bladder is empty and contracted.

Byasson states that corrosive sublimate takes two hours to reach the urine, and four hours to reach the saliva. He never found it in the perspiration. He considers it to be completely eliminated in twenty-four hours after it has been taken.

In chronic or slow mercurial poisoning the symptoms generally presented are loss of appetite, metallic taste in the mouth, fetid breath, soreness of the gums, increase of salivary secretion, pain in the stomach and abdomen, with diarrhea, quick pulse, hot skin, weakness, and emaciation. A bluish line has been noticed at the edge of the gums, as in lead-poisoning.

Salivation, although often absent in acute mercurial poisoning, is nearly always observed in the chronic form. As this symptom accompanies the use of many other drugs, it cannot, of itself, be regarded as a proof of the administration of mercury. In a doubtful case the matter may always be decided by a chemical examination of the saliva for mercury. Doubtless other mineral poisons are eliminated by this secretion, and their presence might be detected in it with proper attention.

The relationship between salivation and mercurial poisoning is a subject of considerable importance, since charges of malpractice have often been made against physicians in cases of profuse and fatal salivation, accompanied by necrosis and gangrene, in which, in some instances, no mercury whatever had been administered, and in others where the dose has been exceedingly small. It is well known that there is no fixed, definite period when the salivation comes on ; rarely befor two dayes, often later.

In a case reported by Wood, in which a teaspoonful of corrosive sublimate had been swallowed, salivation was profuse in the course of a few hours. It has been suggested that this very early flow of saliva was probably due rather to the local irritant action of the poison than to the result of absorption.

An important fact not to be lost sight of in this relation is that salivation may be produced by various other agents besides mercurials, such as potassium iodid, iodin, the preparations of copper, lead, bismuth, arsenic, antimony, digitalis, croton oil, cantharides, colchicum, and other drugs. A case has been mentioned to the author where a patient was profusely salivated by a single dose of five grains of potassium iodid. It is true that in the majority of the instances of non-mercurial salivation there is an absence of the usual mercurial fetor of the breath and the coppery taste, but it would appear from some recorded cases that these symptoms have been equally noticed in the salivation produced by arsenic and bismuth.

Another point of consideration is the great difference in the susceptibility of persons to the mercurial impression. Thus it is almost impossible to salivate a very young, healthy child. Certain morbid conditions of the system, however, such as anemia and albuminuria, seem to predispose to its action. A dose of compound cathartic pills (containing only three grains of calomel) has been known to produce very severe ptyalism. Christison states that three five-grain doses of blue pill, one every night, proved fatal; and that two grains of calomel have caused ulceration of the throat, exfoliation of the jaw, and death. Such severe results are, however, quite infrequent.

Mercurial salivation may be intermittent, ceasing for a

time and reappearing without the further exhibition of the medicine during the interval.

Furthermore, salivation may arise spontaneously from mechanical irritation of the mouth, or as the result of exhausting diseases, especially among the children of poverty and squalor, who are surrounded by bad hygienic influences. Among the last-named subjects, the two diseases, *cancrum oris* and gangrene of the mouth, are of frequent occurrence. The symptoms of these conditions strongly resemble a very severe case of mercurial ptyalism, so that the diagnosis may be difficult. If, in such a case, the physician should have happened to have administered, at the beginning of the sickness, even a small dose of calomel, it might easily become a serious question to determine whether the death actually resulted from the mercury acting as a poison or from the disease; and it would be no difficult matter to get up an action against the medical man for malpractice. Taylor cites a case in point. A charge was made against a medical practitioner for having caused the death of a child, aged four years, by administering an overdose of some mercurial preparation for the treatment of whooping-cough. On the fourth day the child complained of soreness of the mouth; the teeth became loose and fell out; the tongue and cheek were much swollen, and the child died, in the course of a few days, from gangrene of the left cheek. The answer to the charge was that not a particle of mercury had been given—a fact clearly proved from the prescription-book of the medical attendant. This was evidently an instance in which gangrene from spontaneous causes had been mistaken for mercurial poisoning. As before observed, the chemical analysis of the saliva would settle any question of this kind.

Analytic methods.—(1) *As a solid.*—(*a*) A fragment heated on platinum foil is entirely dissipated in white, acrid fumes, which condense on a cool surface in white, radiating crystals. (*b*) Touched with a drop of sodium hydroxid solution, it turns yellowish; calomel, under similar circumstances, becomes black. (*c*) A solution of potassium iodid imparts a bright scarlet color; this is a very delicate test. A drop of this latter solution placed upon a piece of bright copper, in contact with the smallest fragment of corrosive sublimate, will produce a bright, silvery stain upon the copper, especially if it be rubbed with the finger; this stain is immediately removed by heating it. (*d*) Ammonium sulphid at first turns it yellowish, but subsequently black. (*e*) Heated in a reduction-tube with dried sodium carbonate it sublimes, forming a white ring on the cool part of the tube, which, under the microscope, is seen to consist of minute globules of metallic mercury. The white residue in the tube is shown to contain chlorin by dissolving it in water and applying silver nitrate.

(2) *As a liquid.*—(*a*) A drop evaporated on a glass slide will yield large, needle-shaped, or prismatic crystals. (*b*) Solution of sodium hydroxid gives a yellow precipitate; this, when dried and heated in a reduction-tube, will yield sublimate of mercury globules, with the evolution of oxygen gas. (*c*) Ammonium hydroxid produces a white precipitate. (*d*) Potassium iodid first causes a yellow, and, immediately afterward, a bright scarlet precipitate, soluble in an excess of the reagent. When this is dried and heated, it volatilizes, and condenses in a yellow deposit, which gradually changes to scarlet. (*e*) Stannous chlorid first throws down a white precipitate (calomel), and, if in excess, a dark gray precipitate (metallic mercury), which runs into globules on being

boiled. (*f*) Hydrogen sulphid and ammonium sulphid each causes a whitish precipitate, soon changing to red, and ultimately to black. (*g*) A piece of bright copper put into a cold solution of corrosive sublimate, acidulated with hydrochloric acid, speedily acquires a silvery-white coating of mercury. When the copper slip is dried and heated in a reduction-tube, a sublimate of globules is obtained, easily identified by the microscope. This test is extremely delicate, and will detect the $\frac{1}{10000}$ of a grain, if the copper surface is very small and is heated in a very small tube. According to Wormley, a far smaller quantity—even the $\frac{1}{500000}$ of a grain—may be identified by employing a very small, thin, glass tube, the one-tenth of an inch in diameter, and drawing it out, by heating, into a thin capillary neck. The small fragment of coated copper is introduced through the wider portion of the tube to the point of contraction, and the wider end is now carefully fused shut by the mouth blowpipe, so as to give it the appearance of a small thermometer-tube, the bulb containing the coated copper. The tube is now heated at the bulb, and the capillary end closed. On examination under the microscope, a well-defined ring of mercurial globules will be visible on the capillary-tube, just above the bulb.

In case the mercurial sublimate in the reduction-tube should be dim and unsatisfactory, Tardieu recommends to introduce a minute crystal of iodin into the tube, pushing it down as far as the sublimate with a platinum wire. The open end of the tube is then stopped with wax, and it is kept in a horizontal position for about twelve hours, at a temperature of 30° or 40° C., when the deposit will assume a bright scarlet color, due to the production of mercuric iodid. After removing the iodin, the tube may be gently

and progressively heated from below by the flame of a spirit-lamp, when the scarlet color will change to yellow, and on cooling the latter color will give place to scarlet again. (*h*) Galvanic Test.—This consists in winding a strip of gold around a strip of zinc (or iron) and placing the coil in the acidulated solution. Guy recommends a simpler and equally certain method: To moisten a narrow slip of zinc with water, and to take up as much gold leaf as will adhere to it, and introduce this into the acid solution. The gold will, in a short time, become coated with a silver-colored deposit of mercury. It is then to be carefully washed and dried, and heated in a reduction-tube, when the usual mercurial sublimate will be obtained. The gold test is generally regarded as the most delicate.

Toxicologic Examination.—When the poison was administered in the solid form, fragments of it may be found in the stomach yet undissolved; these should be collected and identified. As corrosive sublimate is easily acted on by albumin, glutin, and other substances, much of it may be changed into insoluble compounds. If the dose taken be small and in the liquid form, it may escape discovery in the contents of the stomach. If the quantity in solution is considerable, it may be extracted by simply agitating it with twice its volume of ether, and, after it has settled, removing the ether by means of a pipette, and allowing it to evaporate spontaneously, when the salt will crystallize in white, silky prisms. These may be purified, if necessary, by dissolving in water or alcohol, and again crystallizing. This method has the advantage of recovering the poison in the exact state in which it was swallowed, without the reservation, however, that ether might act upon any mercurial salt in the presence of a chlorid—*e. g.*, sodium chlorid—similarly.

The stomach and its contents should be prepared in the usual manner, already described, and heated with distilled water and hydrochloric acid. After proper filtration and concentration, a trial test may be made with a strip of copper, allowing this to remain in the solution, if necessary, for several hours. The gold test may be applied in a similar manner. By either of these processes the metal can be recovered in a satisfactory manner. The other tests above mentioned may also be applied as corroborative proofs.

The solid matters remaining, after straining off the fluid, will probably contain much of the poison combined with organic substances. These should be boiled in distilled water, with hydrochloric acid, until disintegrated, then filtered and concentrated, and tested as above. Another method is to dry the solid matters thoroughly, and digest them in warm nitro-hydrochloric acid, by which the insoluble mass is converted into soluble corrosive sublimate. The acid liquid is then evaporated to dryness, the residue dissolved in water and filtered, and the usual tests applied; or the corrosive sublimate is dissolved out by ether.

In the Tissues.—The liver, or other organs, should first be crushed in a mortar, with sufficient alcohol to render filtration easy. Acidulate the mass with hydrochloric acid, and gently warm for some time; then filter through paper, and apply the copper, or the galvanic, test, and hydrogen sulphid to the filtrate. All the solid portions are now to be mixed with water and four parts of hydrochloric acid, and boiled for some time; when cool, they are to be filtered and the filtrate examined as above.

Should arsenic happen to be present in the tissues along with corrosive sublimate, on the application of Reinsch's test both metals will be precipitated on the copper, and

both will sublime from the latter when it is heated in the reduction-tube; but in the cold, mercury alone will be deposited on the copper.

To detect mercury in the saliva, acidulate about two drachms of this fluid with one-fourth of hydrochloric acid, and introduce into the mixture a small piece of bright copper foil, and heat gently for several hours. The gold test may also be used. The silvery deposit will indicate the presence of mercury, which will be confirmed by heating it, when washed and dried, in a reduction-tube, and procuring the characteristic mercurial globules by sublimation.

In examining the urine, evaporate about twelve or fourteen ounces down to one ounce; acidulate this with hydrochloric acid; filter and boil the filtrate, and introduce a fragment of bright copper, and confirm as directed above.

It should be remembered that death may ensue from corrosive sublimate and no mercury be found in the tissues, as where the person has survived for a number of days. Also, as in the case of other poisons, there may be a failure to detect it in the stomach after death, even when large doses had been swallowed.

On the other hand, the detection of minute quantities of mercury in the organs is not always evidence of poisoning, inasmuch as the person may have lately taken blue pill or calomel as a medicine; hence, caution should be exercised in reference to this point.

Corrosive sublimate is usually estimated quantitatively as sulphid by carefully washing and drying the precipitate obtained by hydrogen sulphid. Every 100 grains of dry sulphid are equivalent to 116.8 grains of corrosive sublimate. Sometimes stannous chlorid is used to precipitate

mercury from solution. The globules should first be purified by boiling them in a solution of sodium hydroxid, and afterward in hydrochloric acid. Every 100 grains of mercury represent 135.5 grains of corrosive sublimate.

Other compounds of mercury may occasionally prove poisonous, as the mercuric oxid, mercuric chlorid, sulphids, nitrates, and sulphates. The symptoms, treatment, and analytic investigations in such cases are essentially the same as indicated above.

LEAD COMPOUNDS.

In the free state, **Lead** is not considered poisonous, except when freely divided, when it will be dissolved in the stomach. All its salts are poisonous; with perhaps the single exception of the sulphate, which is very insoluble.

Acute poisoning by lead compounds is rare, except as the result of accident. On the other hand, chronic or slow lead-poisoning is of frequent occurrence, since there is no element more constantly and insidiously introduced into the human system than lead under its varied forms. In the arts, the workmen in this metal inhale the fumes and powders in smelting the ores and manufacturing white lead. Painters, plumbers, pewterers, and glazers of pottery are all exposed to similar danger. Even sleeping in a freshly-painted room has seemed to cause an attack of colic and paralysis. Taylor alludes to himself as having suffered from this latter cause.

The frequent handling of pewter vessels, and especially of new type, has produced lead palsy. The use of glazed pottery is another source of contamination, arising from the action of acids, such as vinegar, and of oils and fats; also

of alkalies on the glaze, which consists largely of litharge (lead monoxid). Even milk has become poisonous in this way. Cider and beer, drawn through leaden pipes, may become contaminated in the same manner. Wine may become affected by contact with the shot left in the bottles through carelessness. New rum is apt to contain lead, derived from the leaden worm of the still, while old rum is free from this adulteration. This is ascribed, with great probability, to the fact that old rum, being kept in oak casks, is deprived of its lead by the tannin of the cask.

Certain medicinal substances often contain small amounts of lead, derived from the mode of their manufacture. Alkaline solutions, when kept in flint-glass bottles, soon become impregnated with lead. Commercial sulphuric acid almost invariably contains lead derived from the leaden vessels in which it is prepared.

Many articles in domestic use are not infrequently contaminated by lead, as flour (from the plugs of lead imbedded in the millstones), sugar, snuff, tobacco, chocolate, and bonbons—the latter articles from the impure tin-foil wrappers. Numerous cases of lead-poisoning have been traced to the use of chrome yellow (lead chromate), as a substitute for eggs in making buns and noodles. Canned goods often contain lead; even when put up in glass cans lead may be dissolved from the rubber washers, containing lead carbonate, placed under the cover.

The external application of the preparations of lead is often the cause of slow poisoning, as in handling the metal, already alluded to; the use of hair-dyes and cosmetics; and even from the glazed lining of hats. The direct application of white lead to the scalded surface, as a dressing, has been known to produce symptoms of lead colic.

Probably the most frequent source of chronic lead poisoning is through drinking-water which has, in some way or other, been in previous contact with metallic lead. The conditions under which this occurs are not fully understood. Rain-water, which is frequently preserved in cisterns for drinking purposes, should never be collected from a leaden roof, nor be conducted through leaden pipes, nor in any way come in contact with this metal. On the other hand, most river and spring water, which always contain more or less of saline ingredients, generally exert little deleterious influence upon lead, in consequence of the action of some of the salts existing in the water; these form an insoluble film or coating upon the surface of the lead, thus preserving it from any further action of the water. Free acids in the water very much increase the danger of contamination.

Another cause of contamination may arise from a galvanic action between lead and other metals together, especially when in contact with water containing carbonic acid. Danger also arises from a leaden cover being over a pump or cistern. The vapor of the water (which is equivalent to distilled water), impinging on the metal surface, dissolves off the oxid and carbonate, which may in time fall into and contaminate the water.

The only compounds of lead of toxicologic interest are the acetate and carbonate.

Lead Acetate (*Sugar of Lead*) occurs in commerce in masses of white or light-brownish crystals, somewhat resembling loaf sugar in appearance. It has an acetous odor, and a sweetish, astringent taste. It is soluble in water; less so in alcohol. Its aqueous solution is often turbid from the presence of carbonate.

It is not a very active poison. It is much used in medical practice, but its continued employment has occasionally resulted in bringing on symptoms of lead-poisoning.

In doses of an ounce or two it acts as a powerful irritant, causing burning pains in the throat and stomach, and thirst, vomiting, twisting, colicky pains, with tenderness in the abdomen, obstinate constipation, retraction of the abdominal walls, anxious countenance, cold sweats, and convulsions. The urine is diminished in quantity. In protracted cases there is often paralysis of one or more of the extremities. Its influence on the nerve centres is marked by giddiness, stupor, convulsions, and coma. In some cases there is purging of bloody matters, though usually the fecal discharges are hard, dry, and black. The peculiar blue line upon the edge of the gums, characteristic of chronic lead-poisoning, may sometimes be observed in acute cases.

The fatal quantity is uncertain; an ounce has been swallowed with impunity, though a less quantity has occasioned alarming symptoms. The fatal period is equally uncertain, varying from a few hours to several days.

The proper antidotes are soluble sulphates, especially magnesium sulphate, which forms insoluble lead sulphate. At first, however, vomiting should be promoted by zinc sulphate; afterward opium and castor oil may be required. The urine should be frequently examined for the presence of lead.

Post-mortem Appearances.—Often no well-marked lesions are discoverable. Sometimes there is inflammation of the alimentary tract. Sometimes the inner coat of the stomach and bowels is covered with a thick, whitish layer of mucus mixed with the poison, beneath which the membrane is reddened, or even abraded. The intestines are generally

found contracted. As regards chronic cases, there is nothing very definite to record except the contraction of the large intestines and the flabby and whitish appearance of the muscles specially affected.

Chronic Poisoning.—This may result from the continued internal use of any lead compound; but it is more frequently produced among artisans working in white lead and litharge, or by the accidental introduction of the metal into the system through drinking-water or articles of food.

The earlier symptoms are grouped under the names of *Lead Colic*, *Painters' Colic*, or *Colica Pictonum;* the latter symptoms are named *Lead Palsy.*

Lead Colic.—The earlier symptoms are obstinate constipation and indigestion, with great depression. Then there is a feeling of twisting, grinding pain about the umbilicus, which may be rather relieved by pressure. The abdomen is hard and retracted; sometimes there are scanty, hard evacuations, with much suffering. The urine is scanty and voided with difficulty. The countenance is dull and anxious; skin, cold and clammy; pulse, about natural; respiration, quick and catching; loss of appetite, with dryness of mouth and throat; the breath is fetid, and there is often a metallic taste in the mouth. A characteristic sign of saturnine poisoning is the blue line at the margin of the gums, where they join the teeth, especially noticeable on the incisors. This is probably due to the deposition of lead sulphid in the capillaries of the gums, as can be shown by the microscope. Silver and mercury compounds occasionally produce a somewhat similar blue line, and it is wanting in some cases of chronic lead-poisoning. When once established, the condition is very persistent.

Lead Palsy.—Lead colic, if allowed to continue un-

checked, is very apt to terminate in paralysis, especially after repeated attacks of the former. Again, it may come on without any previous attack of colic. It usually affects the upper extremities. At first there is a dull, numb feeling in the skin of the fingers and forearms, trembling of the arms and legs, unsteadiness of gait, loss of power in the hands and arms, which gradually waste away. The extensors are more affected than the flexors, so that when the arm is raised the hand drops by its own weight, whence the common name of "wrist-drop" for this disease. If unchecked, brain symptoms present themselves, such as giddiness, torpor, and apoplexy; sometimes there are epileptic fits, edema, albuminuria, and convulsions, ending in coma and death.

Lead has been found, after death, in the brain, and especially in the gray matter of the spinal cord; also in the bones, liver, and kidneys. Doubtless, many cases of obscure spinal, cerebral, and cardiac disease are really owing to chronic lead-poisoning—the element having been introduced unsuspectedly into the system.

Analytic Method.—I. *In the Solid State.*—Lead acetate heated in a test-tube evolves an acetous odor, and fuses into a white mass; if the heat is continued, it again fuses and slowly chars, and is converted into a reddish-brown mixture of the oxides of lead. Heated on charcoal, before the blowpipe, it yields globules of lead, with a surrounding incrustation of yellow oxid. A fragment dropped into a solution of potassium iodid instantly turns yellow; touched with ammonium sulphid, it immediately is blackened.

II. *In the Liquid State.*—(1) A drop evaporated on glass yields opaque needles, which turn yellow when touched with a drop of potassium iodid solution or solution of

potassium dichromate ; or black, by ammonium sulphid. (2) Dilute sulphuric acid causes a white precipitate, soluble in hot hydrochloric acid and in large excess of sodium hydroxid. (3) Potassium iodid gives a bright yellow precipitate, soluble in boiling water, which deposits it in brilliant yellow hexagonal scales on cooling. This crystalline form, which is seen under moderate magnifying power, is highly characteristic. (4) Potassium dichromate gives a bright yellow precipitate. (5) Hydrogen sulphid is a delicate test. The black sulphid is confirmed by heating it on charcoal, before the blowpipe ; or by dissolving it in nitric acid, by the aid of heat, evaporating to dryness, dissolving in water, and applying the usual tests. (6) A drop or two of the solution, slightly acidified with acetic acid, is put into a platinum capsule, and a strip of zinc is made to touch the platinum through the liquid ; crystals of metallic lead are deposited on the zinc ; or a fragment of zinc may be placed in the lead solution in a watch glass, when very soon metallic lead will be deposited upon the zinc in an arborescent form. A salt of tin, under similar circumstances, would yield an arborescent deposit of tin. Hence, the deposit must be further tested by dissolving it in nitric acid and applying the usual tests.

Toxicologic Examination.—As lead acetate is easily precipitated by many organic substances, such as albumin, casein, mucus, etc., the poison may exist both in the soluble and insoluble conditions. As a trial test, a good plan is to wet a piece of bibulous paper in the suspected solution and expose it to a jet of hydrogen sulphid gas, which will blacken it if it contains any lead. If the presence of the element be indicated, the mixture should be acidulated with pure nitric acid and boiled for some time ; when cold, it should

be filtered, and the solids on the filter thoroughly washed and reserved for future examination. Concentrate the filtrate by evaporation and treat with hydrogen sulphid; allow the precipitated sulphid of lead to collect, pour off the supernatant water, boil in dilute nitric acid, add sufficient distilled water, and apply the usual tests.

The solids on the filter should be dried and incinerated in a porcelain capsule; dissolve the ash by heat in dilute nitric acid, filter, and treat with hydrogen sulphid, and prove the precipitated sulphid.

If a sulphate has been given as an antidote, a white precipitate of lead sulphate may be found in the stomach. This should be collected and boiled with potassium hydroxid (previously tested to insure its freedom from lead) and the solution tested with hydrogen sulphid, or it may be boiled with ammonium carbonate, and the resulting lead carbonate decomposed by acetic acid.

The solid organs (liver, spleen, etc.) may be examined either by boiling with nitric acid and water, evaporating to dryness, incinerating in a porcelain crucible, and again dissolving by heat and dilute nitric acid; or by directly incinerating them in a porcelain crucible, and dissolving out the lead with strong nitric acid, evaporating to dryness, diluting with water, and precipitating with hydrogen sulphid.

Since organic matters retain lead with great tenacity, the substances should not only be carbonized, but brought completely to an ash. Boucher has shown that the carbon retains lead residue, which resists, to a considerable extent, the action of solvents. This was verified in some examinations made by Drs. Reese and Leffmann.

As regards the localization of lead in the different organs, this metal seems to be eliminated from the system largely

through the liver and kidneys. That which is eliminated by the liver is found in the feces, which have lately been shown to contain a considerable proportion of the total lead eliminated. It is found in the brain and spinal cord, but in smaller quantities than in the above-mentioned organs.

Since lead remains in the system for a considerable time, inquiry should always be instituted in case of the detection of only a minute quantity, in reference to the possibility of its accidental introduction into the system through the occupation, mode of living, etc., of the individual.

The examination of the urine should never be neglected, since lead is eliminated from the system often through this secretion. From fifteen to twenty ounces of urine, acidulated with nitric acid, should be evaporated to dryness, incinerated as above directed, and the ash treated as already described.

For the detection of lead in sweetmeats, slightly moisten them with water and put them on a plate, placing in the centre a little capsule containing about a drachm of ammonium sulphid, and cover the whole with a tumbler. If lead be present the sweetmeats will, after a short time, be blackened by hydrogen sulphid evolved.

Lead Chromate (*Chrome Yellow*).—Commercial chrome yellow often contains considerable lead carbonate and some lead hydroxid, which, being more soluble in the gastric juice, doubtless increase the activity of the drug. It has been much employed, not only as a pigment, but also extensively to impart a yellow color to confections and buns. In the latter case it is used as a cheap substitute for eggs, in order to give the desired rich yellow tint. Within the past few years a considerable number of cases of chronic

lead-poisoning, from the use of buns colored with this salt, occurred in Philadelphia, many of which proved fatal. To Dr. David D. Stewart is due the credit of having detected this important fact. He diagnosed lead-poisoning in cases in which investigation had been made by other physicians without result, and, finally, after much inquiry, traced the source of the poisonings to certain bakers. Most of the cases exhibited the usual marked symptoms of chronic lead-poisoning, although some, especially the fatal ones, suffered from more pronounced eclamptic symptoms than is usual. Drs. Reese and Leffmann made a toxicologic examination of portions of the bodies of five of the fatal cases, at different periods after death, varying from one week up to two years. In every instance positive evidence of the presence of lead was afforded: in one body, in the spinal cord; in four bodies, in the liver; in two cases, in the kidney; in one case, five months after death, in the brain.

Chromium was not sought for in the above examinations.

Lead is quantitatively determined as a sulphid. Every 100 parts of dry sulphid represent 93.31 parts of the oxid, or 158.37 parts of crystallized acetate.

COPPER COMPOUNDS.

Copper is not actively poisonous in its free state, but may dissolve in the stomach and produce marked symptoms. Copper coins swallowed may thus produce dangerous results. The inhalation of copper alloy in fine powder by artisans who work in so-called gold printing, causes serious results, such as constriction and heat of throat, vomiting, loss of appetite, and severe itching of the parts of the body

covered with hair, which, on examination, are found to be of a deep green color.

Cases of accidental copper-poisoning can sometimes be traced to want of cleanliness in cooking, or to keeping food in copper vessels, particularly such food as contains a vegetable acid, vinegar, common salt, or any kind of oil or fat. So long as copper utensils are kept perfectly clean and bright, little risk is incurred in using them; but if cleanliness be neglected, a poisonous deposit collects, which will contaminate any food with which it may come in contact. There is no risk in boiling articles of food or preserves in clean copper vessels, although it is unsafe to keep these articles, cold, in the same vessels; in the latter case, the atmospheric air acts upon the metal at the point of contact of the contained substance. Dr. Falconer gives an instructive example of this. A servant left some sauer-kraut, for only a couple of hours, in a copper pan which had lost its tinning. Her mistress and daughter, who ate of the cabbage, died after twelve hours' sickness. Wildberg found the cabbage so strongly impregnated with copper that it was detected with metallic iron. There is risk in the use of copper boilers. In one case no less than 3.5 grains to the gallon was found in water drawn from a kitchen boiler.

The inference from the above facts would be that it is somewhat unsafe to employ copper vessels either for cooking, or, still more so, for preserving articles of food. Even *tinned* copper vessels are not always safe, because the tinning may consist of an alloy of tin and lead, and the latter might, in its turn, prove a source of danger.

The alloy termed Dutch-metal, used for ornamenting cakes and confectionery as a substitute for gold leaf, may

also prove a source of poisoning; likewise the blue and green papers used as wrappers for bon-bons, although the chief source of danger from the latter arises from the arsenic contained in their composition.

The fine green color of many samples of pickles, peas, and preserved fruits is often due to the addition of a copper compound, as verdigris or blue vitriol. This may be easily detected by placing the suspected article in ammonium hydroxid, when, if copper be present, it will turn blue. Another method is to plunge a bright needle into the article; if copper be present, it will speedily receive a reddish coating of the metal.

All copper salts are poisonous; those of most importance are the sulphate (blue vitriol, blue stone), and the subacetate (verdigris). The arsenite and aceto-arsenite have already been described under the head of Arsenic. A copper carbonate produced by the action of moist air on the metal, or on brass, is sometimes called verdigris.

The salts of copper are rarely used for homicidal poisoning, as they can be so readily recognized both by their color and taste. Occasionally they have been taken suicidally, and more rarely by accident. The sulphate has been employed for producing abortion.

Symptoms.—The sulphate may be taken as a type of all the salts. In large doses it speedily produces active vomiting, which usually expels much of the poison. There are pains in the stomach and bowels, great thirst, purging, headache, prostration, small, frequent pulse, with increased flow of saliva. The matters vomited are bluish or greenish; those from the bowels are greenish, and tinged with blood. Sometimes there are severe cramps and convulsions. There is also suppression of urine, and, in fatal cases, paralysis and

tetanus have preceded death. Jaundice is also an occasional result. Dr. Tidy speaks of it as "the specially diagnostic symptom of copper-poisoning." It is not met with in poisoning by either arsenic or mercury compounds.

The symptoms of slow poisoning (which is generally the result of the accidental introduction in articles of food) are an acrid, styptic, coppery taste in the mouth, dry and parched tongue, coppery eructations, continual spitting, nausea and vomiting, colicky pains in the bowels, diarrhea of bloody stools, with tenesmus, great thirst, heat of skin, small and tense pulse, scanty urine, headache, vertigo, faintness, cramps of the legs and convulsions ; occasionally, jaundice and a blue line on the margin of the gums.

Fatal Dose.—Not positively determined. Half an ounce of verdigris has proved fatal, and an ounce of the sulphate ; but larger quantities have been swallowed without producing death. The usual emetic dose is five to fifteen grains. The usual fatal period is from four to twelve hours.

Treatment.—Free vomiting should be assisted by the use of warm diluent drinks. The best antidote is albumin in the form of white of eggs, as for corrosive sublimate. Milk is also very useful.

Morbid Appearances.—These indicate the action of a powerful irritant to the mucous membrane of the alimentary canal, from the throat downward. The lining membrane of the stomach is inflamed, softened, and sometimes ulcerated. It usually exhibits a bluish or greenish appearance, due to the color of the salt taken. The same is true, also, of the intestines. As a somewhat similar appearance may result from the appearance of bile, it is proper to distinguish between them by the addition of ammonium hydroxid, which will impart a deep blue color if copper is

present, but will cause no change in the green color if due to bile. Perforations have been found in the small intestines ; the rectum is occasionally ulcerated, and the lungs congested.

Analytic Methods.—All the salts of common copper possess either a blue or green color. A few other salts are thus colored, as some of the cobalt salts, blue, and some of those of nickel, chromium, and uranium, green. When heated in the blowpipe flame they impart to it a beautiful green color ; and when heated on charcoal, with dry sodium carbonate, before the blowpipe, globules of copper are obtained.

Copper Sulphate, blue vitriol, occurs in large crystals, soluble in water ; the solution has a nauseous, styptic, metallic taste. The verdigris of commerce occurs in masses of a light green or bluish-green color. It is soluble in water and in dilute acids.

(1) Ammonium hydroxid produces a bluish precipitate which is redissolved by an excess of the precipitant, yielding a beautiful, clear, dark, purple-blue solution ; this color is immediately removed by an acid. The salts of cobalt, nickel, and chromium give somewhat similar results.

(2) Potassium ferrocyanid gives a reddish-brown precipitate, insoluble in excess of the reagent, but soluble in ammonium hydroxid. If the copper solution be very dilute, no precipitate may take place, but only the distinct brownish-red discoloration.

(3) Hydrogen sulphid, or ammonium sulphid, yields a brownish-black precipitate of copper sulphid. This should be corroborated by boiling in nitric acid, evaporating to dryness, dissolving in water, and applying the usual tests.

(4) A piece of bright iron immersed in a slightly acidulated solution of copper acquires a coating of copper. If the solution be very dilute, it should be concentrated by heat and a very small iron surface should be exposed; a fine sewing-needle may be suspended in it for some hours. After it has received the copper coating, it may be removed and put into a porcelain capsule, with a little ammonium hydroxid, which, in a short time, will assume a blue color.

(5) The galvanic test consists in placing the copper solution, slightly acidulated, in a platinum dish, and touching the latter, through the liquid, with a piece of zinc. The copper will be deposited on the platinum in the form of a reddish incrustation. The latter may be dissolved off the platinum by dilute nitric acid, evaporating to dryness, moistening it with water, and testing it as above directed.

Toxicologic Examination.—A portion of the copper may be found in a soluble, and some in an insoluble, state. The liquid part has usually a bluish or greenish color. This should be filtered, concentrated by heat, and a trial test, by means of a bright sewing-needle, applied. Any reddish deposit on the latter should be examined, as above mentioned. Sometimes the needle may acquire a reddish coating simply from ferric oxid; ammonium hydroxid will serve to distinguish them. If a large amount of copper should be indicated, hydrogen sulphid should be passed through it until all the copper is precipitated. This precipitate is to be treated after the manner above described. If the amount of copper be extremely small, the galvanic test is the most suitable. The filtered liquid, acidified with sulphuric acid, is placed in a platinum capsule, and fragments of pure zinc are put into it; wherever there are points of contact between the two, there will be a reddish deposit on the platinum.

This should be washed, and the copper dissolved off with a drop or two of dilute nitric acid. The nitric solution is to be evaporated to dryness, diluted with water, and tested as before described.

If neither of the above tests reveals the presence of copper, it cannot be present in the liquid matters ; but the solids may possibly contain it. These should be boiled with dilute hydrochloric acid and water, filtered, concentrated by heat, and tested.

Traces of arsenic are sometimes found in the sulphate ; when the latter has been taken as an emetic, traces of this substance have been discovered in the matter vomited, and in the stomach (Taylor).

In searching for the salts of copper in the stomach, this organ should be carefully examined for blue or green particles. After treating the stomach and its contents in the usual manner, with the addition of water and hydrochloric acid, and filtering and concentrating by heat, the iron and galvanic tests may be used as trial tests. Hydrogen sulphid should then be passed through the liquid until all the copper sulphid is precipitated. This precipitate should be washed, boiled in dilute nitric acid, and evaporated to dryness ; if much organic matter is present, it should be moistened with strong nitric acid and heated until all the organic matter is destroyed. The dry residue is now dissolved in dilute nitric acid, and again evaporated to dryness, dissolved in water, and the usual tests applied.

In the Organs.—These should be finely divided and thoroughly dried, and then incinerated in a porcelain crucible, and the resulting ash treated with pure hydrochloric acid by heat, and then evaporated to dryness ; dissolve in water and apply the usual tests. Copper remains longer

than arsenic in the tissues and organs ; as long as sixty days in the liver and lungs, according to Orfila.

In the Urine.—Evaporate six to eight ounces to dryness ; treat the residue with the nitric acid and potassium chlorate, with the aid of heat, to complete incineration. Dissolve the resulting ash in hot dilute nitric acid, and evaporate to dryness. Dissolve the residue in warm water, and test as above.

Copper is generally found in minute amounts in the human body, especially in the liver and brain. It is doubtless introduced by articles of food. It is not known to be hurtful in these small quantities. It exists in minute proportions in certain vegetables, which, doubtless, obtain it from the soil. The discovery of faint traces of copper in the body after death is, therefore, no proof of copper poisoning.

Copper may be determined quantitatively as the free element, every 100 parts of which are equivalent to 393.8 parts of crystallized sulphate.

ZINC, BISMUTH, TIN, IRON, AND CHROMIUM COMPOUNDS.

CASES of **Zinc-poisoning** are comparatively rare. In the free state zinc would soon be acted upon in the stomach, and converted into a chlorid, which might occasion serious results. The sulphate and chlorid are the preparations most likely to produce poisonous effects.

The zinc of commerce (spelter) is apt to contain arsenic and other impurities.

Zinc Sulphate (*White vitriol*).—This is a white, crystalline, soluble salt. It has an astringent taste ; effloresces on exposure to the air. It acts as a prompt, active emetic,

without causing much depression of the system; hence is indicated in cases of narcotic poisoning. It is used in small doses as a nerve tonic, and the system soon acquires a tolerance of the medicine.

Fatal Dose.—Half an ounce to an ounce.

Symptoms.—A strong, metallic taste, attended with a burning sensation and constriction of the throat, nausea, violent vomiting, intense pain of stomach and bowels, purging, small and frequent pulse, great anxiety, cold sweats, extreme prostration, dilated pupils, coma, and death. Experiments on animals show it to be a powerful heart depressant.

Fatal Period.—A case is reported of a woman who swallowed, by mistake for Epsom salt, an ounce and a half of this salt, and death ensued in thirteen hours and a half.

Post-mortem Appearances.—Decided evidences of inflammation are seen in the mucous membrane of the alimentary canal, such as redness, softening, ecchymoses, and sometimes ulceration; a yellowish, pultaceous matter, covering the inner surface of the stomach and bowels; congestion of the brain and membranes, also of the lungs, with bloody effusion into the pleura, and a distended, flabby heart.

Zinc Chlorid.—In strong solution this is known as "Burnett's Disinfecting Fluid." It has been used as a disinfectant and as a preservative for wood. It is a powerful corrosive, and has frequently caused death when taken by mistake or for suicide.

The symptoms are in general the same as those produced by the sulphate, only much more intense in their character, and resembling somewhat those of the mineral

acids. They come on immediately after swallowing; the matters vomited and purged are frequently tinged with blood and mixed with shreds of mucous membrane; froth may issue from the mouth, and a white appearance of the inside of this cavity has been noticed. There may also be loss of voice.

Fatal Period.—Taylor records the most rapidly fatal case—four hours. On the other hand, the case may become chronic, lasting for years, and ending in stricture of the esophagus and exhaustion.

Post-mortem Lesions.—In addition to the usual inflammatory signs those of a corrosive will be noticed, such as erosion or destruction of the coats of the stomach. Sometimes these are hard and leathery, thickened, and corrugated. The pylorus has been found constricted, and appearing as if cauterized. Constriction of the esophagus has also been noticed, together with a softened condition of its mucous membrane. The brain and lungs are congested; the heart not affected, but usually distended. The blood is dark and uncoagulated.

Treatment.—Assist the evacuation of the poison by the free use of mucilaginous drinks. The best antidote is albumin, as in corrosive sublimate and copper-poisoning. Milk should be freely used. Opium should be given to combat the irritation.

Analytic Methods.—In the solid state the sulphate may be distinguished from Epsom salt and oxalic acid (which it much resembles in appearance) by exposing a small fragment, mixed with sodium carbonate on a piece of charcoal, to the flame of the blowpipe; it quickly fuses and the vapor forms an incrustation on the charcoal, which is first yellow, and becomes white on cooling. A solution of potassium

dichromate applied to a crystal of zinc sulphate turns it yellow, which is not the case with Epsom salt.

In Solution.—(1) The alkalies precipitate the white hydroxid, which is soluble in excess of the precipitant. (2) The alkaline carbonates throw down the white carbonate, insoluble in excess of the precipitant, but soluble in excess of ammonium carbonate. (3) Potassium ferrocyanid gives a white precipitate. (4) Hydrogen sulphid throws down the white sulphid, soluble in hydrochloric acid. This should always be verified by dissolving it in hot hydrochloric acid, filtering, diluting, and subjecting it to the other tests.

Toxicologic Examination.—In a case of suspected poisoning it should always be remembered that zinc sulphate may have been administered as an emetic ; hence, although discovered in the body after death, it may not have been the actual cause of death. If found, other poisons should also be sought for. The organic matters, along with a little acetic acid, should be gently heated for some time in order to dissolve out the zinc that may have combined with albumin, fibrin, etc. After cooling, the solution should be filtered and concentrated, and then treated with hydrogen sulphid. The precipitated sulphid is collected on a filter, washed, and dissolved in strong nitric acid. The nitrate is evaporated to dryness, dissolved in water, and subjected to the usual tests.

As the preparations of zinc usually contain iron, the presence of the latter metal will more or less modify the reactions of the former. The iron may be separated by an excess of ammonium hydroxid, which will precipitate the iron oxid, while it retains the zinc oxid in solution.

The tissues (liver, kidney, spleen, etc.) may be examined

either by boiling with dilute nitric acid, evaporating to dryness, and adding small quantities of nitric acid, and heating until all the organic matter is destroyed, or else by incinerating the perfectly dried viscera in a porcelain crucible, and treating the resulting ash with nitric acid; evaporating to dryness, and dissolving the residue in water; acidulate with hydrochloric acid; again evaporate to dryness; dilute with water, and apply the usual tests.

Zinc chlorid is often employed for embalming the dead.

Quantitative Estimate.—Zinc is usually determined as oxid. The boiling solution is precipitated with sodium carbonate. The precipitate is collected on a filter, washed and dried, and then ignited. Every 100 grains represent 354.13 grains of crystallized sulphate, or 167.77 grains of zinc chlorid.

Bismuth Subnitrate (*Bismuth Oxynitrate—Magistery of Bismuth—Pearl White*).—This substance is considerably employed, both medicinally and as a cosmetic. As a medicine it is given in doses of five to thirty grains. Several fatal cases have been reported as resulting from large doses, the symptoms being those of a violent irritant poison. Many authorities ascribe these results to the adulteration of the bismuth with arsenic. Taylor states that this adulteration is very common, and that he detected arsenic in comparatively large quantities in three out of five specimens obtained from London druggists.

This impurity may essentially modify an opinion as to the presence of arsenic in a body when bismuth has been previously administered medicinally. A case occurred in which it was contended that the trace of arsenic alleged to have been discovered in the liver of the deceased, was to

be ascribed to the bismuth subnitrate which had been taken before death. Some of the same material was found to be contaminated with arsenic. The prisoner was acquitted.

Bismuth subnitrate is in the form of a white powder, insoluble in water, but soluble in nitric acid. The solution thrown into water yields a copious white precipitate, which is blackened by ammonium sulphid, and is not soluble in tartaric acid.

A delicate test for bismuth is a piece of paper wetted with a solution of potassium thiocyanate and dried; a yellow spot appears at the point of contact. It is stated that the urine will reveal the presence of bismuth, a few hours after taking the subnitrate, by means of this test.

Salts of Tin.—The only preparations of tin requiring notice are the chlorids. The effects of these salts upon the system are those of the metallic irritants; but the instances of poisoning by them are rare.

Stannous chlorid, tin dichlorid, gives a brown precipitate with hydrogen sulphid. Corrosive sublimate throws down the mercury. Gold chlorid gives a fine purple precipitate—the purple of Cassius. A fragment of zinc precipitates metallic tin in an aborescent form.

Stannic chlorid, tin tetrachlorid, is precipitated yellow by hydrogen sulphid. This sulphid is distinguished from arsenous sulphid by being insoluble in ammonium hydroxid, and from cadmium sulphid by being insoluble in hydrochloric acid. Corrosive sublimate and gold chlorid yield no precipitate with it.

The preparations of **silver, gold,** and **platinum** (with some allied bodies) are all highly irritant and corrosive;

but they so rarely are the occasion of poisoning in the human subject that they need no further discussion here.

Iron Compounds.—*Ferrous sulphate* (green vitriol) is highly irritant in large doses, having proved fatal in several instances. Its action resembles that of copper sulphate, though less violent.

Ferric chlorid in the form of tincture (muriated tincture of iron) is much used in medicine. In large doses it acts as a violent corrosive poison. Christison records the case of a man who swallowed, by mistake, an ounce and a half of the liquid, and who died in about five weeks. It is occasionally used as an abortive.

Preparations of Chromium.—The salts of chromium most used in the arts are the potassium chromate, dichromate, and lead chromate. The two former are violent irritants in large doses; sometimes acting, also, as corrosives to the lining membrane of the alimentary canal. The latter has been noticed under LEAD.

Potassium dichromate may be distinguished—(1) by its deep orange-red color; (2) by solution of lead acetate, which precipitates the yellow lead chromate; (3) by silver nitrate, which throws down a deep red precipitate; hydrogen sulphid gives a dingy green sulphid.

OXALIC ACID.

VARIOUS oxalates, especially acid potassium oxalate and calcium oxalate, occur frequently in plants, *e. g.*, rhubarb, wood-sorrel, dock, lichens, etc. Oxalic acid is extensively used in the arts, under misleading names. It is rarely

employed for homicidal poisoning, since it would be easily detected by its sour taste ; but it is sometimes resorted to for suicidal purposes, and it has been frequently the cause of accidental death, from its being mistaken for magnesium sulphate (Epsom salt), which it resembles in appearance.

Symptoms.—These depend very much on the size of the dose and the degree of concentration. In the quantity of half an ounce to an ounce, it acts as a prompt, violent, corrosive poison. In smaller doses and more diluted, its irritant effects may be much lessened or altogether lost ; but its remote, specific operation on the heart and nerve-centres is very observable in the acute pain in the back, extending down the limbs, attended with tingling and numbness, and with tetanic spasms, together with occasional narcotism. On the heart it acts as a decided depressant.

When swallowed in a very large dose, and dissolved in a small quantity of water, the effects are immediate. An intensely sour taste is followed by a burning sensation in the gullet, extending down to the stomach ; violent pain in the abdomen, increased by pressure ; constriction of the throat ; vomiting of a greenish-brown or black matter, sometimes mixed with blood. If the patient lives, purging of a similar character sets in. The remaining symptoms are those of collapse, such as extreme debility, a cold, clammy skin, feeble, rapid pulse, and hurried respiration. There are also soreness of the mouth, swelling of the tongue, intense thirst, restlessness, and distressing cough ; also, frequently, cramps, and numbness of the legs and arms, loss of voice, acute pain in the back and head, delirium and convulsions—symptoms that indicate the action of the poison on the nervous system. As in the case of other violent poisons, the above-mentioned symptoms are

liable to many exceptions and anomalies ; thus, vomiting and pain may both be absent.

Christison mentions a case where leeches that had been applied to the epigastrium of a patient who had been poisoned by this acid, fell off dead, showing evidently that it had passed into the circulation. In cases of poisoning the urine contains crystals of calcium oxalate in abundance ; also, albumin and tube-casts, and, according to some writers, deposits of similar crystals are found within the tubules.

Fatal Dose.—Half an ounce to an ounce is regarded as a fatal dose for an adult. Dr. Taylor quotes a case where one drachm of solid crystals proved fatal to a boy sixteen years old in eight hours. There are, however, cases on record where much larger doses have been swallowed without causing death.

Fatal Period.—In a large, concentrated dose, oxalic acid is one of the most energetic poisons known. Christison calls it "the most rapid and unerring of all the common poisons." Ogilvie reports the most rapidly fatal case known, where death occurred in three minutes after swallowing it. In other cases, death has followed in ten minutes ; the majority of cases prove fatal within one hour. Again, instances have occurred where the patient has survived for many hours, and even days. Beck alludes to the case of a woman who died from the secondary effects of the poison, after several months of suffering.

Treatment.—This should be prompt, in order to be of any service. The best antidotes are chalk and magnesia, mixed up with milk. The alkalies and their carbonates are inadmissible, on account of their forming soluble poisonous compounds with the acid. Lime-water and oil are useful. Opium is indicated to relieve the severity of the symptoms.

Post-mortem Appearances.—The lining membrane of the mouth, throat, and esophagus will usually be found white, shriveled, and easy of removal ; it may be covered over with the brown matters discharged from the stomach. The mucous membrane of the esophagus may be entirely separated, displaying a surface of a brown color, and raised in longitudinal folds. The stomach, which is frequently contracted, contains an intensely acid, brown, gelatinous fluid ; the mucous membrane, if death has been rapid, may appear soft and pale, often without marks of decided inflammation ; but if death has been delayed, it is usually black in some places, and in others intensely congested and in rugæ, with portions peeling off, revealing a gangrenous condition of the subjacent tissue. Such cases resemble those of sulphuric acid poisoning. Perforation of the stomach is rare.

The intestines are usually highly congested, if death has been at all delayed. The lungs generally, and the brain occasionally, have been found congested. The heart is sometimes quite empty, and at others distended with dark blood. The kidneys exhibit a peculiar white zone in their cortical parts, which the microscope shows to be owing to an accumulation of calcium oxalate. The blood throughout the body is fluid. A few cases have occurred where all morbid appearances have been absent.

Analytic Methods.—(1) As a solid. When pure, it occurs in colorless four-sided crystals, of an intensely sour taste (by which it is immediately distinguished from magnesium sulphate), soluble in water, especially hot ; soluble, also, in alcohol, but insoluble in ether, and nearly so in chloroform. It is completely volatilized by heat, leaving no residue ; this is not the case with the magnesium and zinc sulphates, for which it has been mistaken.

(2) *As a Liquid.*—It reddens litmus paper; a drop evaporated to dryness leaves long, slender prisms. (*a*) Silver nitrate gives a copious white precipitate of silver oxalate, distinguished from the chlorid and cyanid by being soluble in cold nitric acid. If this precipitate is thoroughly dried and heated on platinum foil, it is completely dissipated in a white vapor, in a succession of puffs or slight detonations. (*b*) Calcium sulphate gives a white precipitate of calcium oxalate, which is distinguished from the carbonate and phosphate by being insoluble in acetic acid, but being soluble in nitric, and rather less so in hydrochloric acid. Calcium sulphate will also precipitate solutions of barium. strontium, and lead; but these sulphates are insoluble in nitric acid. (*c*) Barium chlorid, strontium nitrate, and lead acetate all precipitate white crystalline oxalates, which are soluble in nitric and hydrochloric acids; but these tests are of inferior value to the former ones. (*d*) Copper sulphate yields a faint bluish-white cupric oxalate, which is almost insoluble in nitric acid.

Toxicologic Examination.—If the contents of the stomach are highly acid, the poison may probably be separated by dialysis, or by digestion with distilled water, at a moderate heat, for some hours, and then filtered, the filtrate concentrated, and tested with copper sulphate. If this test affords evidence of the presence of oxalic acid, the liquid may be evaporated to crystallization, and the crystals thus obtained redissolved in pure alcohol, and the solution again crystallized.

It is usually recommended to treat the first filtrate with an excess of solution of lead acetate; wash the precipitated lead oxalate on the filter; then diffuse it thoroughly in pure water, and pass through it a current of washed hydrogen

sulphid, until all the lead and organic matter is thrown down. Heat a little while, to expel the excess of hydrogen sulphid, then filter, and crystallize the filtrate by evaporation. Purify the crystals, if necessary, by resolution, and apply the usual tests.

It may happen that all the oxalic acid in the stomach has been neutralized by the antidotes that were administered,—lime or magnesia,—in which case the contents of the stomach would not be acid. Here, the inspected solids should be collected, and thoroughly washed with warm water and the liquid decanted off; if this liquid is acid, it should be reserved for examination; if not acid, it may be thrown away. The solids should then be diffused in pure water, and boiled for some time with pure potassium carbonate, which decomposes the oxalates, forming soluble potassium oxalate and insoluble calcium carbonate and magnesium carbonate. These are separated by filtration, and the solution concentrated by gentle heat, until the crystals are formed.

In a case of alleged oxalic acid poisoning it might be objected that the presence of a minute quantity of oxalic acid found in the stomach after death might be due to rhubarb or sorrel that had been eaten by the deceased. The answer to this is that if there is an entire absence of all the characteristic symptoms of this active poison, the discovery of a small quantity of the acid is certainly no evidence of poisoning; but, on the other hand, if the peculiar symptoms of this poison and morbid lesions are present, then the obtaining of only a small amount of the acid should not negative the suspicion of poisoning.

In a case of suspected poisoning by oxalic acid, the urine should always be examined for an increase of the octahedral

crystals of calcium oxalate. This fluid should be collected in a conical glass, and the sediment which collects after some time should be examined with the microscope.

It should, however, be remembered that these crystals may be found in the urine of persons who have partaken of food such as rhubarb and sorrel, containing oxalates.

To detect free oxalic acid, or a soluble oxalate in the urine, add a little acetic acid to dissolve out the phosphates, if present, and concentrate to about one-fourth its bulk, then add lead acetate in excess, and filter; decompose the lead oxalate with hydrogen sulphid, and treat the filtered solution as above directed.

Stains of this acid on cloth, parchment, paper, etc., may be discovered by boiling them in water, and applying the usual tests. The color of these stains on black cloth is orange and brownish-red. This acid is sometimes employed to remove writing ink, in cases of forgery; but usually there are left on the paper traces of iron, existing in the ink, which can readily be recognized by applying a solution of potassium ferrocyanid, which will turn it blue.

Oxalic acid is usually estimated quantitatively as lead oxalate; every 100 parts of the dried pure oxalate are equivalent to 42.5 of the crystallized acid.

Calcium oxalate is almost invariably found in the urine in the form of octahedral crystals, and often in larger masses constituting "mulberry" calculus.

Acid Potassium Oxalate—(*Salt of Sorrel—Essential Salt of Lemons*).—This salt is much used in the arts. It is almost as active a poison as oxalic acid; the symptoms, dose, and lesions are very similar to those of the acid. It is distinguished from the latter (1) by heating a fragment

on platinum foil ; an ash is left, potassium carbonate, while the acid is entirely dissipated ; (2) it crystallizes in feathery forms ; (3) it is distinguished from cream of tartar by lime water, which precipitates both ; but the calcium tartrate is immediately re-dissolved by tartaric acid, while the oxalate is insoluble. This salt is a natural ingredient in the sorrel.

Tartaric and **Acetic Acids** act as powerful irritant poisons, in the concentrated state, and in large doses. They have both produced fatal results when taken in doses of an ounce. Their proper antidotes are the alkaline carbonates, and chalk or magnesia.

CARBOLIC ACID.

Carbolic Acid—(*Phenic Acid—Phenol*)—is one of the products of the distillation of coal tar. When pure, it is in the form of white acicular crystals, and can also be obtained by synthesis, which, when exposed for some time to the light, usually acquire a reddish tinge. They have a strong affinity for water, and liquefy when exposed to the air. It is not, however, very soluble in water ; much more so in alcohol, ether, and glycerol. It has a burning taste, and a peculiar, strong, creasote-like odor. It is sometimes called coal-tar creasote. It is powerfully antiseptic, quickly destroying many microörganisms. Applied in its undiluted state to the skin, it acts as a corrosive and anæsthetic, corrugating and hardening it. Taken internally, undiluted, its effects are those of an energetic, corrosive, and neurotic poison.

Carbolic acid, from its extended employment in industries, etc., has of late years become a very frequent cause of poisoning.

Symptoms.—Intense burning pain in the mouth, throat, and stomach; the pupils are contracted; the conjunctiva insensible to the touch; marked odor of the acid exhaled from the breath; the skin cold and clammy; the temperature rapidly falls; the pulse becomes weaker and weaker, but fluctuates in its beats; respiration is labored, and ultimately stertorous; vomiting of a frothy mucus sometimes occurs; the mouth is white and hardened from the local effects of the acid. Coma usually precedes death, which may also sometimes be accompanied by convulsions. Death may occur within an hour from swallowing the poison; in one case, within ten minutes. The urine, as shown by Stevenson, is often of an olive-green color.

Many of the above symptoms have been produced by the external application of the acid, especially to denuded surfaces.

Fatal Dose.—Dangerous symptoms have occurred from doses of six or seven drops or grains. The deaths recorded have resulted from doses of one to two ounces; but a much less quantity would certainly prove fatal.

Treatment.—The stomach should be washed out with demulcent liquids. A solution of lime in strong syrup (saccharated lime) may be used as a neutralizing agent. Sodium sulphate is regarded by some as a true antidote. Solution of soap may also be employed. Oil is the best outward application to the skin. Stimulants must be freely given to combat the collapse.

Post-mortem Lesions.—The mouth and esophagus are usually white, soft, and corroded, but sometimes hardened and corrugated. The brain is generally normal, but occasionally congested, the fluid in the ventricles exhaling the strong odor of the acid. The lungs are usually gorged

with blood. The left ventricle of the heart is generally contracted, while the right is flaccid. The blood is uniformly dark-colored and fluid. The odor of carbolic acid is detected in the stomach, sometimes in the intestines, and even in the other viscera. The mucous lining of the stomach has been found white, hardened, and wrinkled; but, again, highly congested and corroded. The bladder is usually empty, any urine passed being of a dark or olive-green color.

Analytic Methods.—The odor is probably the best test. It has a slight acid reaction, and forms salts with bases. It imparts a transient, greasy stain to paper. It coagulates albumin. It gives a deep violet color to ferric chlorid, and a bluish tint to a mixture of ammonium hydroxid and sodium hypochlorite; if this be acidulated, it turns red. Bromin water causes a whitish-yellow flocculent precipitate; if this be treated with sodium-amalgam, carbolic acid is set free (Landolt). Heated with potassium cyanid, it gives a red tint. A splinter of wood, moistened with the acid, and afterward dipped into nitric or hydrochloric acid, turns of a greenish-blue tint when dry.

Toxicologic Examination.—Generally, the characteristic odor of the acid will be perceived in the body after death. The organic matters should be distilled along with dilute sulphuric acid.

Carbolic acid can generally be detected in the urine, both by the odor and by chemical reagents. The urine may either be distilled without sulphuric acid (as it is said this acid may develop carbolic acid from some of the normal constituents of the urine); or by agitating it with an excess of ether, and subsequently removing the ethereal layer by means of a pipette, and evaporating in a shallow dish, a minute oily residue is left, having the character of carbolic acid.

POISONING BY CROTON OIL, ELATERIUM, CASTOR BEANS, COLCHICUM, AND SAVIN.

Croton oil is a fixed oil, extracted by pressure from the seeds of *Croton tiglium*. It is used in medicine as a powerful purgative, in doses of one or two drops. In over-doses, it acts as a violent irritant to the gastro-intestinal mucous membrane, causes excessive vomiting and purging, followed by collapse, as in cholera. Its poisonous properties seem to be dependent on a peculiar fatty acid named *crotonic*, which exists in the oil in variable quantities. When deprived of this acid the oil is harmless.

Croton oil is of a light yellow color, has an unpleasant odor, and a hot, acrid, burning taste. Another variety has a darker color. It is very soluble in ether. Nitric acid, with the aid of heat, imparts to it a dark-brown color.

Death has resulted in one case from taking, by mistake, an embrocation containing thirty minims of the oil. In another case, two and a half drachms proved fatal in four hours; while in a third instance, half an ounce of croton oil was taken by mistake, and after exciting violent vomiting and purging, with symptoms of collapse, the patient recovered after fourteen days.

Dr. Reese attended a case of accidental poisoning by this substance, arising from swallowing an embrocation containing at least one drachm of the oil. The patient, a young lady, recovered after experiencing very severe symptoms.

This oil has occasionally been administered with a poisonous intent, in successive small doses, so as to produce symptoms resembling those of gastro-enteritis. A case of this character was tried at Mount Holly, N. J., in which a woman was convicted of an attempt to poison her son,

for the purpose of obtaining his life-insurance money. The purchase and possession of the poison were ascribed by the defendant to having been intended by her for the cure of her corns.

Analysis.—Separate the oil from the contents of the stomach by means of ether, and evaporate the ethereal solution spontaneously, and test the resulting oil with nitric acid and heat.

Elaterium.—This substance is procured from the juice of *Ecballium officinarum*, or squirting or wild cucumber. It is used in medicine as a powerful drastic purgative. Its effects are very similar to those of croton oil. One grain of good elaterium has produced very violent effects. It owes its activity to a neutral resinous principle, elaterin. Nitric acid has no action upon it. Sulphuric acid turns it of a reddish-brown color.

Castor Beans are derived from the *Ricinus communis*, and yield by pressure the castor oil of commerce. The seeds contain an irritant, poisonous principle, which causes them to act violently when swallowed. They have occasionally proved fatal. In one case three seeds destroyed life in an adult male in forty-six hours, and twenty seeds proved fatal to a young lady in five days, after violent symptoms, strongly resembling those of malignant cholera.

Colchicum.—The *Colchicum autumnale*, or meadow saffron, contains a powerful alkaloid principle, colchicin, which strongly resembles veratrin in many of its properties. It abounds chiefly in the bulb of the plant, but is also found in the seeds.

The effects of a large dose upon the system are those of

a violent irritant, such as burning pain in the throat and stomach, great thirst, vomiting, and soreness, purging, cramps, cold, collapsed skin, feeble pulse, dilated pupils, suppression of urine, and rapid exhaustion. Sometimes there are delirium and convulsions.

The strength of the preparations of colchicum varies greatly, depending upon the time of gathering the plant, and also upon its place of growth.

Death has resulted in seven hours, and again has been delayed for several days. Generally, it occurs within twenty-four hours. Less than half an ounce of the wine of the root, forty-eight grains of the dried bulb, and a table-spoonful of the seeds have severally proved fatal. Accidental poisoning occurred in Montreal, in 1873, in a company of eight or nine persons. They had freely partaken of what they supposed to be ordinary wine, but which was really wine of colchicum. In the course of a few hours they became alarmingly ill, with nausea, vomiting, excruciating pains, purging, cramps, and prostration. Five of the cases terminated fatally within thirty-six hours.

Post-mortem Appearances.—These consist of inflammation of the stomach and bowels. In some instances no morbid appearances exist. In one case the pia mater was much congested, when there was an absence of inflammation from the stomach. The lungs are usually deeply congested.

Colchicin occurs in fine, white crystals. It is soluble in water, has a feeble, alkaline reaction, and a bitter, acrid taste. Its best test is nitric acid, which gives it a violet color, changing to blue and brown. It differs from veratrin in its negative action with sulphuric acid. It may be recovered from organic mixtures by a modification of Stas'

process. Less than half a grain of colchicin has proved fatal. There is no known antidote to it.

Savin.—The tops of the *Juniperus sabina* contain a volatile yellow oil (oil of savin), which may be procured by distillation. Both powder and oil are employed in medicine, and both possess powerful irritant properties. They are seldom or never used as poisons, but they frequently produce fatal results when used as abortives. Although not believed to possess specific ecbolic properties, uterine contractions may follow their powerful irritant effects upon the gastro-enteric mucous membrane; but death is a more frequent result without the expulsion of the fetus.

In cases of poisoning by the powder this may often be discovered in the stomach and bowels by microscopic inspection. The oil may be separated by distillation from the contents of the stomach, and then agitating the distillate with ether, in which it is soluble, and allowing the solution to evaporate. It is recognized by its peculiar terebinthinate odor.

VERATRIN—YELLOW JASMINE—GELSEMIN AND GELSEMIC ACID—POISONOUS MUSHROOMS.

Black Hellebore (*Helleborus niger*), formerly named *Melampodium*, is sometimes employed in medicine. It is a powerful irritant to the stomach and bowels, and has proved fatal in overdoses, occasioning violent vomiting, purging, abdominal pain, cold sweats, collapse, and convulsions.

Green Hellebore (*Veratrum viride—American Hellebore—Indian Poke*).—This species possesses very active prop-

erties, and has occasioned fatal results. The tincture is used in medicine as a powerful cardiac depressant. Numerous fatal results have followed its incautious use. Several active alkaloidal principles exist in both this drug and in *V. album*—which, though resembling veratrin in some points, are distinct from it.

White Hellebore (*Veratrum album*).—This is the most poisonous of all the hellebores. The powder produces violent sneezing. Taken internally, it causes a sense of burning heat and constriction of the throat, great anxiety, nausea, vomiting, and purging, pain of the abdomen, trembling of the limbs, great prostration, cold sweats, very feeble pulse, dilatation of the pupils, giddiness, convulsions, insensibility, and death. Death has occurred in three and six hours after taking it. The active principle is *Veratrin.*

Veratrin.—This alkaloid, as above mentioned, exists in the *V. album* and *V. viride*, but it is usually procured from the seeds of *Veratrum sabadilla.* As found in the shops, it is in the form of a white powder. It may be crystallized with difficulty. It has an acrid, bitter taste, followed by a sense of dryness in the throat. It is a violent irritant to the nostrils, causing excessive sneezing. It is insoluble in water, soluble in alcohol, ether, chloroform, benzene, and amylic alcohol. Heated on porcelain it melts and blackens, evolving a pungent vapor.

Effects.—Taylor mentions the case of a lady on whom the $\frac{1}{16}$ of a grain occasioned most alarming symptoms, such as insensibility, cold sweats, failing pulse, and collapse. It acts as a local irritant to the stomach and bowels, and at the same time as a general depressant.

Analytic Methods.—The characteristic test is sulphuric acid. A drop applied to the pure alkaloid imparts a yellow color to it, followed by a reddish tint, which gradually passes to a deep crimson. This change is brought about immediately by heat. Even a very dilute acid causes this reaction by evaporating to dryness. It is stated that even less than the $\frac{1}{50000}$ of a grain of veratrin may be thus detected.

Other substances give a red color to sulphuric acid—such as solanin, narcein, salicin, piperin, etc.; but these are immediately colored by cold sulphuric acid, whereas veratrin requires the lapse of some time before the change is effected.

Other reagents are gold chlorid, bromin in hydrobromic acid, and iodin in potassium iodid.

Trapp's test consists in warming the colorless solution of veratrin in concentrated hydrochloric acid, when a persistent dark-red color results.

In organic mixtures, veratrin may be separated by a modification of Stas' process, and the ultimate chloroform extract tested by sulphuric acid. Wormley states that by this test he was enabled to recognize the presence of veratrin in an ounce of blood of a cat which had been killed, in less than one minute, by two grains of veratrin.

Yellow Jasmine (*Gelsemium sempervirens*).—The root of this plant is considerably employed in medicine, especially in the Southern States of our country, in the treatment of neuralgia and analogous complaints. It has frequently produced fatal results, the symptoms somewhat resembling those produced by veratrin.

The most prominent of these are dimness of vision; the

motor nerves of the eye are attacked first; objects cannot be fixed; the eyelids become paralyzed, droop, and cannot be voluntarily raised; pupils are dilated; eyes staring; face congested, though sometimes pale; lips livid; tongue thick, speech impaired; partial paralysis of the legs; much general prostration; small and frequent pulse; breathing slow and labored. Sometimes there are spasms of the throat; and after large doses tetanic convulsions have been observed.

The time when the symptoms appear varies from a few minutes to an hour or more; and fatal results have occurred in one hour up to several.

Fatal Quantity.—The tincture and fluid extract are officinal preparations. The latter is about four times stronger than the former. Twelve minims of the fluid extract proved fatal to a child three years old; and thirty-five drops of the tincture caused death in another case in an hour and a half. A teaspoonful of the fluid extract and half an ounce of the tincture may be considered as fatal doses.

Treatment.—Speedy evacuation of the stomach, followed by stimulants, internal and external. The hypodermic use of large doses of morphin is strongly recommended; also the use of electricity.

Wormley succeeded, in 1870, in isolating two distinct principles from the *G. sempervirens*—gelsemin and gelsemic acid.

The former is a strong alkaloidal, nitrogenized base, and constitutes about 0.25 per cent. of the dried root; the latter is a non-nitrogenized body, crystalline and feebly acid. Its proportion in the root is about 0.5 per cent.

Gelsemin is a colorless, odorless, difficultly crystallizable solid, persistently bitter to the taste, slightly soluble in water

and alcohol, very soluble in chloroform, ether, bisulphide of carbon, and benzene. It forms soluble salts.

Sulphuric acid dissolves it without change of color if perfectly pure ; but as commonly found, it slowly colors it brown, which changes to a purple if warmed. If a fragment of potassium dichromate be stirred in the acid solution, a red color is produced, which soon changes to a blue tint. In this respect it somewhat resembles the reaction of strychnin ; but they can readily be distinguished by the action of nitric acid, which gives to gelsemin a bluish-green color when evaporated, but does not affect strychnin. These are the most satisfactory modes of recognizing gelsemin.

Gelsemic Acid.—A colorless and nearly tasteless solid, crystallizing in tufts or needles ; slightly soluble in hot water, very soluble in ether and chloroform. Its nitric acid solution, when treated with ammonium hydroxid, develops a deep blood-red color, even in very minute proportions.

Its sulphuric acid solution when acted upon by ammonium hydroxid immediately produces a mass of needle-shaped crystals. This is an exceedingly delicate test. Its fluorescent properties also characterize gelsemic acid, in the presence of an alkali. An extremely minute quantity may thus be recognized.

The above two bodies may be extracted from organic mixtures, as the contents of the stomach, by the usual process pursued for the alkaloids. The resulting filtered acid solution should be shaken up with ether, which will remove the gelsemic acid ; and the residue rendered alkaline, and extracted by ether and chloroform in the usual manner, to procure the gelsemin. Wormley succeeded in recovering both of these principles from the stomach of a woman who was poisoned by three tablespoonfuls of the fluid extract,

several months after death ; and likewise from the tissues and blood of animals poisoned with the extract.

Poisonous Mushrooms.—Many varieties of fungi are edible, but a few possess noxious and even fatal properties. It is not always possible to distinguish between the two classes, inasmuch as climate, season, and idiosyncrasy may occasion the difference. The poisonous principles of some fungi appear to be volatile, since boiling renders them innocuous.

Symptoms.—The effects of poisonous mushrooms on man are usually those of the narcotic irritants, causing violent vomiting, purging, abdominal pain, thirst, anxiety, cold sweats, together with giddiness, dimness of vision, trembling, dilated pupils, delirium, illusions, stupor, coma, convulsions, and death.

It is stated that the very same fungi have acted on some members of a family as vomitants only, and on others as narcotics.

Generally, the symptoms show themselves within one hour—especially the narcotic symptoms. Orfila relates the following interesting case of poisoning of a family of six persons by the *Amanita citrina.* The wife, servant, and one of the children had vomiting, followed by deep stupor, but they recovered. The husband had violent cholera ; he recovered also. The two other children became profoundly lethargic and comatose ; emetics had no effect, and death ensued. The individuals who recovered were not completely well until three weeks after the fatal repast.

Morbid Appearances.—These are imperfectly described ; they indicate a great tendency to rapid putrefaction, lividity of the body, fluidity of the blood, absence of cadaveric

45

rigidity, numerous ecchymoses in the serous membranes and parenchymatous organs, signs of violent and even gangrenous inflammation of the stomach, and congestion of the vessels of the brain, with decomposition of the tissues.

The chief interest connected with this subject is the fact that the symptoms occasioned by eating poisonous fungi might easily be attributed to poisoning—homicidal or otherwise. A microscopic examination of the contents of the stomach and bowels will usually reveal the botanical character of the fragments of the fungi, if the poisoning has been due to them.

CANTHARIDES—POISONOUS ANIMAL FOOD—SAUSAGE POISON —TRICHINOSIS—CHEESE POISON—POISONOUS FISH— PUTRESCENT FOOD—POISONED FLESH.

Cantharides.—The *Cantharis vesicatoria*, or Spanish fly, is much used in medicine, both externally as a vesicant, and also internally. In large doses it acts as a powerful local irritant to the alimentary canal, and also to the genito-urinary organs. It is often used as an abortive, and has not infrequently produced fatal effects when employed for this purpose. It owes its active properties to a crystalline principle named cantharidin, which exists in the proportion of about one grain to half an ounce of the powder.

Symptoms.—A burning sensation in the mouth and throat, with constriction and difficulty of swallowing; violent pain in the abdomen, increased by pressure; nausea, and vomiting of a bloody mucus and shreds of membrane, along with great thirst and dryness of the fauces. Soon the characteristic impression on the genito-urinary organs displays itself in a dull, heavy pain in the loins, an urgent and incessant

desire to urinate, which is attended with great pain and the voiding of merely a few drops of bloody urine, accompanied by tenesmus. Priapism frequently occurs in males, and swelling and heat of the labia in women, together with abortion, at times, in pregnant females. Purging generally supervenes, the stools being bloody and mucous, and accompanied by tenesmus. Sometimes there is profuse salivation, and in fatal cases faintness, giddiness, and convulsions. If the substance has been taken in the form of powder, the characteristic shining green particles may generally be recognized in the discharges from the stomach and bowels. If the tincture has been taken, the above symptoms come on more rapidly.

All the above symptoms have been produced by the external application of cantharides.

Fatal Dose.—Twenty-four grains of the powder and an ounce of the tincture have caused death.

Treatment.—Speedy evacuation by emetics and cathartics (castor oil); opium, and stimulants.

Post-mortem Appearances.—Intense inflammation of the mucous membrane of the alimentary canal, from the mouth downward, also of the ureters, kidneys, and bladder. Congestion of the brain has been observed. The peculiar shining green particles can generally be distinguished in the stomach and bowels. But if the tincture has been swallowed, it will be necessary to procure the extraction of cantharidin from the organic matters.

Analytic Methods.—The suspected materials should be dried, and digested in successive portions of ether, until exhausted; this will dissolve out the cantharidin. The ethereal solution is to be evaporated until nearly dry, and the residue should be spread on oiled silk, and a portion

applied to the lips, or on the thin portion of the skin of the arm, when the resulting vesication would denote the presence of cantharides.

Poisonous Animal Food.—It occasionally happens that animal food, such as sausages, cheese, fish, mussels, etc., produce poisonous symptoms, either owing to some idiosyncrasy on the part of those who have partaken of them, or depending upon some noxious agent connected with the food itself, either introduced from without or spontaneously generated within.

Such cases are often attended with symptoms of a violent character, which naturally suggest poisoning, and they then become the subjects of medico-legal examination.

Sausage Poison.—Physicians and physiologists are disposed to attribute some instances of so-called sausage poisoning to the presence of an entozoön, named *Trichina spiralis*, which especially infests the muscles of the hog, and which lives for some time after the animal is slaughtered, but is killed by thorough cooking. When meat containing live trichina is eaten, these rapidly multiply in the stomach and intestines, and penetrate the muscular coat of these viscera, and spread rapidly through the muscles generally. The sudden liberation of a multitude of these parasites from their cysts, in the intestines and muscles, produces the irritation of the bowels and the subsequent loss of muscular power that are so characteristic of trichinosis.

In the other cases the true noxious agent is undoubtedly ptomaïns generated in the decomposing meat. It is more likely to occur in uncured sausage.

It may readily happen that the symptoms thus occasioned

might be attributed to poisoning by one of the mineral irritants. A careful microscopic and chemical examination of the suspected food, or of a fragment of a muscle of either a living or dead subject, will be necessary, and will often reveal the true source of the disorder.

The symptoms of **Cheese poisoning** are very similar to those of ordinary irritant poisoning. The cause of the development of poisonous properties in cheese has been revealed by the discovery, by Vaughan, of a peculiar ptomaïn to which he has given the name of tyrotoxicon. Instances of cheese poisoning are more common in Germany than in this country.

Poisonous Fish. — In certain individuals, probably through idiosyncrasy, many kinds of fish act poisonously —*i.e.*, they excite severe gastro-intestinal symptoms, resembling cholera morbus. In many cases some chemical change in the food itself has taken place.

Mussels, which are quite extensively used in Europe as food, occasionally produce most violent and alarming symptoms, the exact cause of which is not known.

These symptoms are not of a uniform character. Sometimes they are those of a simple irritant, such as nausea, vomiting, purging, pain in the abdomen, cramps, small and frequent pulse. The fatal cases disclose on post-mortem examination evident signs of inflammation. In other instances the gastro-enteric disturbance has been slight, while the nervous symptoms are well marked, such as delirium, insensibility, loss of muscular power, and coma, with dyspnea and convulsions. Again, the most conspicuous symptoms have been a peculiar eruption resembling urticaria, along with severe asthma. The symptoms

usually do not appear under the lapse of twenty-four hours; but there are cases where they come on very much earlier. In fatal cases the autopsy usually reveals nothing that will satisfactorily account for the result.

No rational, adequate cause of this singular poisonous action of the shell-fish had been discovered until the recent researches of Brieger revealed the interesting fact that only those mussels are poisonous which inhabit certain filthy waters, whereby they become diseased. From such mussels he succeeded in extracting a specific ptomaïn—mytilotoxin—a crystalline base, capable of forming salts. It is very poisonous, somewhat resembling curarin in its action on animals.

Putrescent or Decayed Meat often produces gastro-enteric symptoms similar to those described above, but they may also be of a typhoid character, or resembling true blood-poisoning. The game that has been kept long enough to delight the taste of the epicure has produced a severe cholera in persons not accustomed to its use.

Putrid animal matter injected into the blood vessels proves quickly fatal. Dissecting wounds thus may produce alarming symptoms, which may terminate in death. In most of these instances the real cause of the trouble would seem to be the production of one or more poisonous ptomaïns by the action of microbes.

Poisoned Meat.—The flesh of an animal or bird which has become poisoned by arsenic, strychnin, or some other deleterious substance may become the cause of poisoning to man. Thus, the common pheasant of this country (*Tetrao umbellus*), which has fed upon the leaves and buds

of the kalmia (laurel), has proved poisonous to persons who have eaten the birds. It is known that the milk of cows and goats that have fed upon the *Datura stramonium* may prove poisonous to those partaking of it. In one case of alleged poisoning by belladonna the defense was that the family had eaten a rabbit pie, and that the animal had fed upon the leaves of the belladonna plant, so that, without being affected injuriously itself, it had conveyed the poison to those who had partaken of it. Nevertheless, many cases of poisoning by animal food which have been supposed to be due to the introduction of some poison into the animal before death, have really been due to changes in the dead flesh through the action of microbes. In some cases it has appeared that the very earliest stages of putrefaction produce more virulent action than the later and more offensive conditions.

CLASS II.—NEUROTIC POISONS.

The second division of Poisons embraces those whose effects are displayed chiefly on the great nervous centres—the brain and spinal marrow. Their symptoms are drowsiness, headache, giddiness, stupor, delirium, convulsions, and paralysis. They produce little or no irritation or inflammation on the mucous membrane of the alimentary canal. Their *post-mortem* conditions are not very distinctly marked, consisting of more or less fullness of the cerebral vessels; rarely effusion of serum; more rarely still, effusion of blood in the brain. It is impossible to diagnose a case of neurotic poisoning by these lesions exclusively.

OPIUM AND ITS PREPARATIONS.

Opium and its preparations give rise to a large proportion of poisoning cases, both in this country and Great Britain. According to the statistics furnished by Blyth, over forty per cent. of all the cases of poisoning in England between the years 1876–80 were due to opium; and these amounted to 393 males and 250 females—total, 643. Out of this whole number, there were but two cases of homicide (infants); 22.4 per cent. of the female cases and 30.5 of the male were suicidal. This is a far higher percentage than that found in any other European country, or in the United States.

Opium is the dried juice of the unripe capsules of the poppy (*Papaver somniferum*). It has a complex composition, containing numerous alkaloids, and also one or two acid principles. Among the alkaloids are morphin, narcotin, codein, narcein, thebain, and papaverin. Meconic acid is the only important acid. In a medico-legal view, the only important bodies are morphin and meconic acid, since, in an analysis for the detection of opium in a case of suspected poisoning, the investigation is narrowed down to the discovery and identification of these two substances.

It should be remembered that different specimens of opium differ in the contained amount of morphin. The U. S. Pharmacopeia requires that opium should contain, when dried, from twelve to sixteen per cent. of morphin. The tincture (*laudanum*) of the shops is far from being of a uniform strength, owing to this variation in the amount of the active principle in the opium, and also to fraudulent dilution. Laudanum contains about six grains of opium to the fluid drachm, which is equivalent to one grain to twenty drops.

The *Acetum Opii* of the old pharmacopeia is about double the strength of laudanum. It was made to imitate the old *black drop*, but is not quite so strong. *Wine of opium* (*Sydenham's laudanum*) is about the strength of laudanum.

Numerous cases of poisoning of children by "soothing syrups" are constantly occurring in large cities. These preparations are not of uniform composition, but opium or morphin generally exist in them.

Symptoms.—These vary according to the size of the dose. A large, but not fatal, dose occasions, at first, general excitement of the system, as evinced by increased fullness and frequency of the pulse, flushed face, brilliancy of the eyes, and increased activity of the brain. This is soon followed by calm repose, which in turn gives place to profound sleep. In proportion as the amount of opium is increased, the first period of excitement is shortened, the more characteristic soporific effects manifesting themselves sooner. In such a case there will be giddiness and drowsiness, rapidly passing into profound sleep or stupor, from which it will be difficult to arouse the patient; this stupor gradually ends in coma. The pupils are contracted. At first, the pulse is full and slow; subsequently it becomes weak. The respiration is generally slow and stertorous; the skin warm, and the face flushed. As the case advances, the countenance becomes pale, the lips livid, the skin cold and clammy, the respiration very slow—we have noticed it reduced down to five or six in a minute; the muscles are relaxed; convulsions sometimes occur just before death, but these are more common in children than in adults. Sometimes there is vomiting, which is to be regarded as a hopeful sign; and occasionally also there may be purging. At times the skin is bathed in a profuse perspiration.

Certain variations in the above symptoms should be noticed. The pupils are usually strongly contracted; toward the termination of the case they may sometimes be dilated. Occasionally one pupil may be contracted and the other dilated. The contracted state of the pupils is usually regarded as a diagnostic sign of opium-poisoning; but Dr. Wilks has shown that this same condition of the eyes occurs in apoplexy of the pons varolii, and that two cases of this latter disease were mistaken for opium-poisoning. The same contraction of the pupil occurs also in uremic poisoning, in the course of Bright's disease.

First Appearance of Symptoms.—This will depend on the size of the dose, the form of administration, and the condition of the stomach at the time. As a rule, the symptoms usually commence within an hour after swallowing the poison. But if taken in the liquid form and in full quantity, they may manifest themselves in a few minutes. We have often seen full narcosis produced in five to ten minutes by the subcutaneous injection of a quarter of a grain of morphin. On the other hand, cases are reported where the symptoms were delayed, even after swallowing very large doses, for many hours. Sometimes a partial remission of the symptoms occurs, and the patient gives hopes of recovery; but they return again only to terminate in death. There seems reason to believe that alcohol tends to postpone the development of the usual symptoms of opium.

Fatal Period.—The average duration of a fatal case is from seven to twelve hours. Cases are reported where the symptoms appeared in thirty-five minutes, and death in three-quarters of an hour; whilst, on the other hand, death has been, in some instances, delayed for twenty-five to forty-eight hours.

Fatal Dose.—Four or five grains may be regarded as the minimum fatal dose for an adult. Children are particularly susceptible to the action of this drug ; in very young infants, fatal effects have resulted from taking two or three drops of laudanum. An infant may be narcotized by the milk of a nurse who has taken opium.

On the other hand, recoveries constantly take place from very large doses—even up to several ounces. It is notorious that the human system soon acquires a remarkable tolerance for this narcotic by habit. De Quincey thus brought himself to the daily use of nine ounces of laudanum, which is equivalent to about three hundred and sixty grains of solid opium.

Occasional instances of idiosyncrasy occur in which the susceptibility to the narcotic influence of opium is greatly augmented ; and also, on the other hand, where there seems to be a natural tolerance for the drug. As regards the opium habit, there can be no doubt of its ultimate deleterious effects upon the human system.

The external application of opium, especially to an abraded surface, may prove highly dangerous and even fatal, especially in the case of infants. Christison relates an instance where a laudanum poultice, applied over the abdomen of an infant to relieve pain, produced fatal narcotism in some hours ; and where, at the autopsy, a strong odor of opium was exhaled from the body, showing how completely the poison had been absorbed.

Post-mortem Appearances.—These are neither certain nor characteristic. There is usually some fullness of the vessels of the brain ; occasionally, extravasation of serum into the ventricles, very rarely of blood. Sometimes there is congestion of the lungs and other vascular organs. The blood

is apt to be fluid. The stomach and bowels may be perfectly natural in appearance. The odor of opium may be observed in opening the body. It is hence impossible to diagnosticate a case of opium-poisoning from the post-mortem appearance exclusively.

Treatment.—Remove the poison from the stomach as speedily as possible by the stomach-pump, or by a prompt emetic, as zinc sulphate or mustard water. In case of inability to swallow, it has been recommended to inject hypodermically a solution of $\frac{1}{16}$ of a grain of apomorphin, which usually produces prompt emesis. The next indication is to overcome the increasing lethargy, by rousing the patient, dashing cold water over the face and chest, and making him walk about between two attendants. He should swallow some strong coffee. Atropin should now be carefully administered hypodermically every half hour, watching its effects upon the pupils. Electro-magnetism should be employed; also artificial respiration, if the other remedies fail.

Potassium permanganate has recently been recommended by Dr. Moor. In poisoning by morphin or its salts he advises the administration of from ten to fifteen grains dissolved in six to eight ounces of water, and this dose repeated every thirty minutes until three or four doses have been taken. When laudanum has been taken, it is advisable to add a few drops of dilute sulphuric acid to the antidote.

As regards the antagonism of morphin and atropin in the human subject, the accumulated testimony of physicians from actual cases cannot be disregarded; $\frac{1}{120}$ of a grain of atropin hypodermically every fifteen minutes until three doses have been given, has been advised. Bokai believes

that the best antidote for morphin is picrotoxin. These two substances act in an opposite manner on the respiratory center, morphin paralyzing its action, while picrotoxin increases it ; hence it may be regarded that a true antagonism exists between these two substances.

Morphin.—When pure, morphin is in the form of colorless bitter rhombic crystals, slightly soluble in water, soluble in alcohol, especially when hot, almost insoluble in chloroform and pure ether, very soluble in acetic ether and amyl alcohol. It is slightly alkaline, forming salts with acids. Its solutions, in common with the other alkaloids, are precipitated by tannic acid. Its salts are soluble in water and diluted alcohol, but insoluble in chloroform, ether, amylic alcohol, and pure acetic ether.

The symptoms produced by morphin resemble those of opium, except that they ordinarily manifest themselves rather earlier, and possibly tend to produce convulsions rather more frequently than opium. Occasionally these convulsions have been of a tetanic character, suggesting the presence of strychnin.

Fatal Dose.—One grain has, on several occasions, produced death. Dr. Reese saw a case in which three-quarters of a grain administered hypodermically proved fatal to a man within twenty-four hours. Still smaller doses thus administered have produced fatal effects. On the other hand (as in the case of opium), enormous doses have been swallowed with impunity. Norris reports a case in which a druggist took, with suicidal intent, seventy-five grains of morphin sulphate. No marked symptoms appeared for an hour and a half. He then became unconscious, but under active treatment, including extract of belladonna, he

entirely recovered on the second day after the occurrence. Other cases have since been reported where still larger quantities (one of 120 grains) were taken, where the patient recovered.

The external application of morphin to an abraded surface has been attended with fatal effects.

There are no characteristic post-mortem lesions produced by morphin. The general appearances are similar to those caused by opium.

Analytic Methods.—Opium is identified by its sensible properties and by its physiological action on animals. The only mode of identifying it chemically is by detecting the presence of its two important constituents, morphin and meconic acid, or some of its other principles. The two former are chiefly relied on.

Detection of Morphin.—I. In the solid state.—(1) Strong nitric acid dissolves it with effervescence, evolving red fumes, and gives an orange-red solution, slowly fading to yellow. Nitric acid also produces a deep-red color with brucin, which, on the addition of stannous chlorid, changes to a bright purple; whereas no change is produced in the case of morphin. (2) Strong sulphuric acid dissolves it without change of color; if now a crystal of potassium dichromate be added, it acquires a green color. (3) Ferric chlorid imparts a deep-blue color to it, changing to green if added in excess. In this test free acid must not be present. (4) Iodic acid, added to a fragment of morphin, along with freshly made starch, produces the characteristic blue color from the liberated iodin. This reaction, however, occurs with other substances. According to Otto, if a fragment of morphin or one of its salts be dissolved in strong sulphuric acid, by the aid of heat, and on cooling a

little water added, with a crystal of potassium chromate, a deep mahogany-brown color is produced.

II. In the liquid state.—(1) Nitric acid, in excess, gives an orange-red color, which becomes light yellow on boiling. (2) Ferric chlorid acts as on solid morphin. (3) Iodic acid in carbon disulphid, added to a solution of morphin, causes a pink or red precipitate, consisting of iodin, in the disulphid. (4) A solution freshly prepared by dissolving five milligrams of ammonium molybdate in one c. c. of sulphuric acid, gives with morphin a purple or crimson, which quickly passes through several shades, and after a while becomes deep blue.

Several other tests are given in analytic manuals, but they are of less value than those enumerated.

Meconic Acid.—Since this acid is peculiar to opium, its detection affords proof of the presence of that substance. In its pure state, it occurs in the form of colorless crystals, tolerably soluble in water, more so in alcohol.

Tests.—(1) Ferric chlorid imparts to either the solid or solution a blood-red color, which is not removed by a solution of mercuric chlorid. The only fallacy likely to occur is from the presence of a thiocyanate, which yields a similar color with the iron salt. Thiocyanates occur in the saliva; but the red color thus given with ferric chlorid is instantly discharged by mercuric chlorid. Strong acetic acid, or its salts, likewise give a red color with the ferric salts; and this color, moreover, is not removed by mercuric chlorid, but if the acetate be previously boiled with dilute sulphuric acid it gives no color with the iron salt. (2) Lead acetate yields a yellowish-white precipitate of lead meconate. (3) Barium chlorid yields a white crystalline deposit of a

peculiar form. (4) Silver nitrate gives a yellowish-white precipitate, which becomes red on adding ferric chlorid.

Toxicologic Examination.—Sometimes, on opening the stomach, the strong odor of opium is readily detected, and also in the matters vomited. The discovery of this poison in the stomach is often unsuccessful, owing, probably, to its decomposition and absorption in the body. This is especially true in the case of infants, in whom a very few drops have sufficed to destroy life. The highest authorities unite in declaring that the analyst will fail to discover the poison in the stomach after death, in the majority of the cases. It is much more likely to be found in the vomit.

The stomach should be cut up in small fragments, adding water with a little alcohol, and acidulating with pure acetic or tartaric acid, and the whole exposed to a gentle heat for about one hour. After cooling, it should be strained through muslin, the solid residue washed with strong alcohol and pressed, and the washings added to the first liquid. The liquid should then be evaporated over a water-bath to a small volume, and when cooled filtered through paper. To the clear filtrate, lead acetate is to be added in excess, which throws down lead meconate. The morphin remains in the solution as an acetate or tartrate. These are to be separated from one another by filtration, and the solid matter washed with water.

(*a*) The solid portion, lead meconate, is to be diffused through water, and treated with hydrogen sulphid gas, which precipitates lead sulphid, and leaves meconic acid in solution ; the liquid is filtered, the precipitate washed, and the filtrate and washings concentrated on a steam bath. A trial test on a small portion of this liquid by ferric chlorid

may be made ; if a deep-red color is imparted, meconic acid may be suspected ; to the remainder of the liquid the other tests may now be applied. If present in sufficient quantity, meconic acid will crystallize out on evaporation of the liquid. If the quantity, however, be minute, the liquid should be carefully concentrated to a small volume and the characteristic tests employed.

(*b*) The filtrate from the lead meconate, containing the morphin in the form of acetate, together with the excess of lead acetate, is to be treated with hydrogen sulphid in order to remove the lead ; then filtered and the filtrate concentrated by gentle heat to dryness. The residue is then treated with a few drops of warm distilled water and a portion of it examined for morphin by the nitric acid, iron, and iodic acid tests ; the remaining liquid should then be made alkaline by pure potassium carbonate (diluting, if necessary, with water) ; it is allowed to stand for half an hour, and is then shaken up with an excess of absolute ether, which will take up the impurities, leaving the morphin unaffected. The ethereal solution is removed by means of a pipette and reserved for future examination, if necessary. The remaining alkaline solution is now to be thoroughly shaken with two or three times its volume of either a mixture of two parts of absolute ether and one of alcohol (as recommended by Wormley), or of two or three volumes of hot amylic alcohol, or of a similar bulk of acetic ether. By either of these processes the morphin is taken up by the solvent, which floats upon the top of the mixture, and which may be removed by a pipette and allowed to evaporate spontaneously on watch-glasses. Ordinarily the morphin thus recovered is amorphous, and may require re-solution in hot alcohol and to be crystallized therefrom by evaporation.

In cases of poisoning by morphin alone (or one of its salts) the above process may be employed, omitting the treatment with lead acetate, inasmuch as no meconic acid is present.

Detection in the Tissues and Blood.—There is generally a failure to detect this poison in the organs and tissues, or in the blood. Yet, on the other hand, cases are reported where it has been discovered in the body several months after death ; by Stas thirteen months after. There is some doubt about the detection of the opium principles in the urine, inasmuch as the results alleged to have been produced by certain reagents and supposed to indicate the presence of morphin or meconic acid have since been shown to be due to substances existing normally in the urine.

The toxicologist should be cautioned against a too hasty conclusion as to the presence of opium, or its alkaloid, upon color tests alone. Orfila relates that Ruspini and Cogrossi found that a decoction of calf's intestines, although no morphin was present, acted upon iodic acid and starch like that alkaloid. In another case morphin was pronounced to be present in the urine by reason of the action of the extract of this secretion on the iodic acid and urates. In the employment of these extraction processes it must be remembered that commercial ether, alcohol, benzene, etc., may contain small amounts of impurities giving reactions which simulate various alkaloids.

Inasmuch as the symptoms of opium poisoning strongly resemble those of apoplexy, it might readily happen that a case of the latter disease, attended with suspicious surroundings, might be mistaken for the former, and the con-

tents of the stomach might even possibly reveal a red color when treated with nitric acid. If no morphin (nor meconic acid) was actually separated, the examiner would not be authorized to pronounce upon the presence of this poison simply from the single reaction above mentioned. Taylor cites an instructive illustration of this hasty conclusion, in which a chemist made oath of the discovery of "distinct traces of morphin" in the stomach; whereas, in reality, no morphin had been taken at all (as was proved by an analysis of the medicine swallowed by the deceased); but the death was due entirely to natural causes.

ALCOHOL.

The poisonous effects of **Alcohol** may be either acute or chronic. The former are witnessed in those cases in which a large quantity of spirits is taken at a single draught. The latter are illustrated in the common dram drinkers, and by a train of symptoms with which we are, unfortunately, too familiar. The former only will be discussed here.

Symptoms of Acute Poisoning.—These come on usually in a few minutes after the ingestion of the poison, if the amount is large. They are, first, giddiness, confusion of ideas, unsteadiness of gait, incoherent talking, followed by stupor and coma. The features have a vacant, ghastly expression, or they may be suffused or bloated; the lips are livid; the pupils usually dilated and fixed; the conjunctivæ are red; an alcoholic exhalation from the breath is perceived; convulsive movements of the limbs; respiration, at first stertorous, becomes more and more difficult; a bloody froth may appear on the lips; involuntary evacuations occur, and death may ensue in half an hour, or even earlier, after the

fatal drink. In other instances the person may apparently recover from the first effects and then suddenly become insensible and die in convulsions. If free vomiting occurs, followed by a prolonged sleep, recovery is apt to take place. The sensibility of the pupil to light may also be regarded as a favorable symptom.

The rapidity with which the symptoms show themselves will depend upon the previous habit of the individual and the strength and quantity of the spirit taken. The very large quantities seem to destroy life by shock.

Acute alcoholism may be mistaken for opium-poisoning and concussion of the brain. Usually the odor of the breath is sufficient to reveal the case, also the dilated pupil; but this condition of the eye is not invariably present. In concussion there are often marks of injury in the head; the face is pale and cold; there is also an absence of the alcoholic odor.

Post-mortem Appearances.—There is generally a remarkable absence of putrefaction in the body. The stomach exhibits marks of intense congestion in the deep-red color of its lining membrane, either diffused or in patches; more or less congestion of the brain and its membranes, with serous effusion under the arachnoid and in the ventricles; sometimes there is a true apoplectic extravasation of blood. The lungs are almost invariably congested. Usually a strong alcoholic odor is perceived from the different tissues of the body; but the organs for which the poisonous fluid displays the greatest affinity are the brain and liver.

Alcohol is very rapidly absorbed into and eliminated from the system, so that if the person has survived several hours all traces of it may have been removed from the body.

Treatment.—Immediate evacuation by means of the stomach-pump or by an active emetic; affusion of cold water over the head; a free supply of fresh air; if there be asphyxia, galvanism may be tried; also ammonium hydroxid and the liberal use of coffee as a drink.

Analytic Methods.—If the case has not been too protracted, the alcohol may be recovered from the stomach and its contents by distillation in a capacious retort on a water-bath with a good condensing apparatus. If the materials are acid, they should first be neutralized by potassium or sodium carbonate. The distillate should be mixed with calcium chlorid and re-distilled. The second distillate is to be shaken with an excess of potassium carbonate (which absorbs the water) and set aside. The stratum of alcohol which rises to the top may then be separated by means of a pipette, and submitted to the following tests: (1) Its taste is hot and pungent; its odor is characteristic; it burns with a pale-blue flame, leaving no carbonaceous residue; if burnt under the mouth of a test-tube moistened with lime water, the carbonic acid will produce a white film upon the sides of the tube. (3) It dissolves camphor. (4) On adding a solution of potassium dichromate and hydrochloric acid the peculiar odor of *aldehyde* is developed, along with the green color of chromic chlorid. In performing this test Taylor recommends conducting the vapor from the retort in which the distillation is going on into a glass tube containing a few fibres of asbestos moistened with a mixture of a strong solution of the dichromate and sulphuric acid (used in this case instead of hydrochloric acid), when the merest trace of alcohol vapor will be sufficient to impart the green coloration.

Both ether and wood spirit will produce this last effect

and likewise yield most of the results of alcohol. Ether may be distinguished by its odor and by the yellow color of its flame; also by its smoky deposit on porcelain. Wood spirit may be recognized by its peculiar color and by its smoky flame on burning.

In the Tissues.—The proof of the absorption of alcohol is afforded in its detection in the blood, urine, and different tissues of the body. If there is a failure to discover it in the stomach it should be looked for in the brain and liver. Buchheim has devised an exceedingly delicate process for detecting it in small quantities in the blood and tissues, based upon the conversion of the vapor of alcohol into aldehyde and acetic acid when passed over platinum-black. As much as possible of the material, neutralized first by potassium carbonate, should be distilled from a capacious retort on a water-bath. The neck of the retort should be slightly inclined, and be wide enough to hold a platinum tray about two inches long and half an inch wide containing the platinum-black. Hanging over each end of the tray is placed a slip of moistened litmus paper and touching the platinum-black. The tray is now pushed toward the body of the retort. As soon as there is any escape of alcoholic vapor by the distillation it will be manifested by the reddening of the litmus paper at the farthest end of the tray, in consequence of the production of acetic acid, while the paper nearest the body of the retort will remain blue. If no reddening of the paper occurs, no alcohol can be present; if the reddening rapidly occurs, the tray should be removed and the vapor should be condensed in the usual way.

As both ether and wood spirit produce a similar effect on platinum-black, this process offers no advantage over the chromic acid process above described, except when

putrefaction has taken place, in which case the hydrogen sulphid evolved might reduce the chromate, but not affect the platinum-black.

A few drops of a liquid containing alcohol added cautiously to a solution of one part of molybdic anhydrid in ten of strong sulphuric acid gives, on gentle warming, a blue color.

To ten c.c. of a clear liquid suspected to contain alcohol add five drops of a ten per cent. solution of sodium hydroxid and warm to about 110° F. Then add drop by drop with shaking a saturated solution of iodin in potassium iodid until the liquid becomes permanently yellowish-brown. If now the liquid be decolorized by the further slow addition of sodium hydroxid, iodoform will be produced if alcohol be present, and can be identified by its color and crystalline form. Unfortunately this reaction is caused by many other bodies, especially acetone, but not by chloroform, chloral, glycerol, or ether, nor by acetic, formic, or oxalic acids.

ANESTHETICS.

This subdivision of *Cerebral Neurotics* comprises those substances that display their power chiefly by producing insensibility to pain and unconsciousness. The Anesthetics here noticed are Ether and Chloroform. Under this head also it will be convenient to speak of Chloral Hydrate, although its action differs somewhat from that of the others.

POISONING BY ETHER, CHLOROFORM, AND CHLORAL HYDRATE.

Ether, often called, erroneously, Sulphuric ether, is a limpid, colorless liquid, of a peculiar odor, and hot, pungent taste; highly volatile and inflammable; sp. gr., 0.735; boils

at 95° F.; burns with a bright-yellow flame, depositing carbon on a cold porcelain surface. Sparingly soluble in water; very soluble in alcohol.

Symptoms.—In large doses it produces much the same effects as alcohol. There is usually a short period of delirious excitement, followed by coma and other symptoms of narcotism, similar to those caused by alcohol.

Post-mortem Appearances.—On account of its less solubility in water, ether is a more powerful local irritant than alcohol. The mucous lining of the stomach and duodenum of a dog poisoned with ether were found to be violently inflamed, the lungs deeply congested, and the heart full of black blood.

The inhalation of ether, as is well known, produces rapid anesthesia. Its immediate effect, when inhaled, is the production of a transient excitement; this is soon followed, if the dose be sufficient, by stupor and insensibility. This last condition may be prolonged for a considerable time by continuing the inhalation. Occasionally the excitement is of a violent character, along with a stubborn resistance to the anesthetic influence; and, again, there may be nausea and vomiting.

Analytic Methods.—Ether is recognized by its odor and taste, by its mode of combustion and volatility, and by its action on sulphuric acid and potassium dichromate—the same as in the case of alcohol.

From organic mixtures, as, *e. g.*, the contents of the stomach, it is to be separated by the same process as that described for ALCOHOL.

Chloroform.—A colorless, limpid liquid, very volatile, giving off a dense vapor; sp. gr., 1.497; boiling point,

142° F. It has an agreeable characteristic odor, and a smart, pungent taste. It is nearly insoluble in water, in which it sinks in globules. It is not easily inflammable. It is a powerful solvent of many organic substances, the alkaloids among others. At a red heat, its vapor is decomposed into chlorin and hydrochloric acid.

Symptoms.—A large dose produces local irritation in the stomach, with, at first, a general stimulation of the whole system, soon followed by a decided narcotism, as shown by insensibility, stupor, convulsions, dilated pupils, flushed face, full and oppressed pulse, and frothing at the mouth. Cases are reported where the pupils were contracted.

Taylor reports a case where a boy, aged four years, died in about three hours after swallowing one drachm of chloroform. It has often caused death in quantities of half an ounce and upward.

When taken by inhalation its impression is more speedy than that by ether. There is, moreover, an absence of the previous excitement attendant on the latter, the patient almost immediately passing into insensibility. It appears to act as a depressant from the first, and if not properly diluted with atmospheric air, it may rapidly produce death. In one case, the fatal result took place in one minute after breathing only thirty drops in the state of vapor; and, in another instance, only fifteen drops proved fatal in a very short time. The immediate cause of death from chloroform vapor appears to be, in the majority of cases, syncope, or the cessation of the heart's action; in others, asphyxia.

Death by the forced inhalation of chloroform was supposed to have occurred in the case for which H. H. Mudgett, *alias* H. H. Holmes, was tried, convicted, and executed

in Philadelphia. The case excited widespread interest on account of the number of crimes of various grades of which the prisoner was suspected. The crime for which he was tried was that of the murder of a man with whom he had arranged to defraud an insurance company by the substitution of a corpse pretending to be that of the insured. The body was found in incipient decomposition several days after death. There was some chloroform in the stomach and also some evidence of an attempt to set fire to the building. It is believed that the chloroform was introduced into the stomach by Holmes, and that the death was really produced by forced inhalation while the victim was decidedly intoxicated.

Post-mortem Appearances.—In death from liquid chloroform, the characteristic odor may usually be recognized, together with slow putrefaction of the body and persistent rigor mortis. There is also much irritation of the stomach, sometimes accompanied with softening, and in one case with ulceration.

In death from inhalation there is very often no lesion discoverable. At times there will be found considerable congestion of the lungs and bronchial tubes, and likewise of the vessels of the brain, together with a dark and fluid condition of the blood.

Treatment.—In poisoning by liquid chloroform, the stomach should be immediately evacuated by the stomach-pump, or by a prompt emetic, and stimulants afterward administered. If inhalation has caused the danger, the chloroform should be immediately withdrawn and fresh air freely admitted; cold affusion should be applied to the face and chest; the inversion of the body (holding it suspended by the feet) is often successful. The tongue should

at once be drawn out of the mouth, to facilitate respiration; artificial respiration and the direct galvanic current should also be practiced.

Analytic Methods.—The odor will usually be present in organic mixtures, such as the contents of the stomach. These should be distilled on a water-bath, and the distillate re-distilled along with calcium chlorid, and the product subjected to the proper tests, as odor, taste, solubility, etc.

Toxicologic Examination.—The contents of the stomach, or the organs properly divided, along with distilled water, should be put into a large flask, the neck of which is fitted with a cork perforated to contain a hard glass tube, bent at right angles, and from twelve to fifteen inches long. The flask is gradually heated on a water-bath, and at the same time the middle of the horizontal tube is heated red-hot by a Bunsen flame. At a red heat, chloroform is decomposed into chlorin and hydrochloric acid. A slip of moistened litmus paper, placed at the mouth of the tube, is first reddened and then bleached; starch-paper, wetted with potassium iodid, is rendered blue; and if the end of the tube be made to dip into a solution of silver nitrate, white silver chlorid will be precipitated. The absence of any free hydrochloric acid in the original material should be first insured by the addition of sodium carbonate.

It is important to remember that if chloral hydrate had been taken by the patient just previous to death, and the alkali be added to the mixture for examination, the chloral will be decomposed into chloroform and produce all the above reactions.

There are certain important questions connected with the administration of chloroform as an anesthetic, with which the physician should be familiar, such as whether

persons asleep may be chloroformed without their being awakened and thus robbed or otherwise maltreated. It has been ascertained by direct experiment that this effect can be produced if the sleep is profound.

Chloral Hydrate.—A solid, crystalline body, having a peculiar, disagreeable, pungent taste and smell; tolerably soluble in water; not inflammable. Sodium hydroxid added to its boiling aqueous solution instantly converts it into chloroform and potassium formate. It reduces copper hydroxid in a manner similar to glucose.

Symptoms.—Chloral hydrate has been much used as a hypnotic. It is not infrequently employed in "drugging" liquor to assist in robbery or rape. Its indiscriminate use has led to many fatal results. There appears to be a tendency to accumulation, and a sudden and dangerous action of the drug. In moderate doses it acts as a hypnotic; in large doses it produces a powerful depressant action on the ganglia at the base of the brain and on the spinal cord, causing feeble action of the heart and lungs.

A full dose generally occasions deep sleep, followed, if the quantity be very large, by fatal coma. The pulse is usually very slow and feeble; the face pale; respiration slow, the heart being ultimately arrested in diastole.

Much discrepancy of opinion exists as regards the fatal dose of chloral hydrate. Numerous instances are reported where ordinary doses of thirty grains have occasioned alarming and even fatal effects; while, on the other hand, enormous quantities—over an ounce—have been swallowed with comparative impunity. As a rule, thirty grains may be considered as a maximum dose, and not to be repeated oftener than every six or eight hours.

Picrotoxin has been used successfully as an antidote to chloral.

Analytic Methods.—The principle involved is the conversion of the chloral into chloroform, through the agency of an alkali, as explained above. The solid matters, properly divided, should be diluted with distilled water, and rendered alkaline by sodium hydroxid, and heated in a flask, and the experiment conducted after the manner described under the head of CHLOROFORM.

SPINAL NEUROTICS.

Nux Vomica is by far the most important poison included under this order of Neurotics. It is the seed of the *Strychnos nux vomica*, a tree growing in India. Several seeds are enclosed in a yellow fruit. The seed is a circular disk, an inch or less in diameter, concavo-convex, of a light-brown color, covered over with short, whitish, silky hairs, extremely tough and difficult to pulverize; excessively bitter to the taste. Several seeds are inclosed in single fruit. They contain two powerfully poisonous alkaloids—*strychnin* and *brucin*, and several other alkaloids of less activity. The amount of contained strychnin is estimated at one-half to one per cent. of the seed.

The smallest fatal dose of nux vomica is thirty grains (about the weight of one seed), and three grains of the alcoholic extract. The symptoms, treatment, etc., are precisely similar to those described under the head of STRYCHNIN.

Strychnin.—Exists in several species of *Strychnos* besides the *S. nux vomica;* it is the poisonous principle of the *S. Ignatia*, or *St. Ignatius' Bean;* it is also found in *False Angustura Bark.*

Strychnin is a very frequent cause of poisoning, whether accidental, homicidal, or suicidal. The celebrated Palmer case, which occurred in England in 1856, brought it prominently before toxicologists.

Symptoms.—These vary somewhat in the time of their appearances, according to the form of the administration. The first effect is a feeling of restlessness and general uneasiness, with a sense of impending suffocation and want of air. Very soon twitching of the muscles and jerking of the limbs and head come on; these are followed suddenly by a violent tetanic convulsion, which pervades the whole body; the legs are stretched out stiffly and widely separated; the feet arched and usually turned in; the arms are flexed and tightly drawn across the chest; the head is bent back rigidly, and the whole body flexed backward so as to rest upon the head and heels (opisthotonos). As the muscles of the chest and abdomen are spasmodically contracted, the respiratory movements become arrested; the face is livid and congested, especially around the lips; the eyes prominent and staring; pupils widely dilated; the muscles about the mouth contracted so as to produce the expression denominated *risus sardonicus;* the pulse is very rapid and feeble. Sometimes there is foaming at the mouth, and the froth may even be tinged with blood. The intellect remains perfectly clear, while the patient is experiencing the most intense suffering, gasping for breath, and seeking in vain for relief in asking to be turned over, or moved, or held. The jaws are not always fixed during a paroxysm; the patient may hence be able to speak; and as there is often great thirst, he may ask for water, but the effort to swallow is apt to intensify the spasm, as in hydrophobia, and cause him to bite upon the vessel.

The paroxysm may last from half a minute to several minutes, when a complete relaxation occurs; the patient now feels exhausted and is bathed in perspiration; the pupils may now become contracted. In a short time, varying from a few minutes to half an hour, the fit returns. It is usually preceded by an apprehension of the impending danger, the special senses being exceedingly acute. The spasm may be brought on by the slightest cause, as the opening of a door, a sudden noise, a current of air, or an attempt to move. In some instances the violence of the spasm is so great as to jerk the patient out of bed. Should the case prove fatal, the paroxysms increase in frequency and violence, until at last death ensues, either from asphyxia, the patient dying in a paroxysm, or from sheer exhaustion during an interval.

Although the intelligence continues unimpaired during the progress of the case, it may happen that it becomes clouded just before the fatal termination, in consequence of the asphyxia causing a deficiency of aëration of the blood, and the consequent accumulation of carbon dioxid. As a rule, when the paroxysms are once established, they progress either to fatal termination or toward a cure within two hours of the seizure, though there may be some exceptions to this rule.

The time of the first manifestation of the symptoms varies from a few minutes to some hours; the average is fifteen minutes to half an hour. Dr. G. H. Barker has reported the case of a young, healthy woman, who took six grains of strychnin, in whom violent symptoms were manifested in three minutes, and death took place in convulsion in half an hour. In Dr. Warner's case, who took, it is supposed, less than half a grain, the symptoms appeared in five

minutes and death occurred in about eighteen minutes. In another case convulsions came on in five minutes. On the other hand, this interval may be protracted for several hours. Dr. Anderson reports the case of a man who took by mistake three and a half grains of strychnin, and experienced no particular symptoms for two hours and a half, when he suddenly fell backward; but on being raised he was able to walk home and finally recovered. Undoubtedly the form in which the poison is administered has much to do with the rapid development of the symptoms. This is shown in a case cited by Taylor of a boy, aged twelve years, who swallowed a pill containing three grains of strychnin, in whom no symptoms were manifested for three hours; they then set in with their usual violence and death took place in ten minutes. This pill had been prepared with mucilage eight months before, and was consequently hard and difficult to dissolve. In the Palmer case, Cook took two pills containing strychnin. No symptoms were observed for an hour and a quarter, after which death occurred in twenty minutes.

There are cases in which the unusual delay cannot be thus accounted for, but in which it must be referred to some individual peculiarity of the patient. Wormley mentions a case where the remarkable postponement of the symptoms for twelve hours appeared to be owing to the effects of a large dose of opium that had been taken simultaneously. Three grains of strychnin, a drachm of opium, and an indefinite quantity of quinin were taken at the same time. Other equally remarkable instances might be adduced, showing the same apparent antagonism between strychnin and opium. Nevertheless, in some experiments with strychnin and morphin combined, made on animals by

Dr. Reese, the latter poison, so far from antagonizing the former, appeared rather to intensify it.

The subcutaneous injection of strychnin, as also its external application to a healthy mucous surface, produces a still more speedy manifestation of its peculiar symptoms. Some clinical experiments of Dr. Chisholm, of Baltimore, made on amaurotic patients, would seem to show that the human system acquires a tolerance of strychnin.

Fatal Dose.—There is great difference as to the susceptibility to the action of strychnin. The average medicinal dose is about the one-sixteenth of a grain, though it is customary to commence with a smaller quantity. The above dose has proved fatal to a child between two and three years old. Dr. G. B. Wood mentions the case of a lady who was thrown into alarming spasms by one-twelfth of a grain. Dr. Reese had personal knowledge of a case of a gentleman who had decided spasms after taking about one-twentieth of a grain. In Philadelphia recently severe symptoms followed the taking of one-quarter of a grain of strychnin sulphate by an adult woman, but a fatal result was avoided.

The smallest fatal dose for an adult recorded is half a grain, which proved fatal to Dr. Warner. Dr. Ogston reports a case where three-quarters of a grain destroyed a man in three-quarters of an hour. A fatal dose for an adult may be stated to be half a grain to one grain.

On the other hand, numerous instances are recorded of recoveries after enormous doses of this poison—ten, twelve, and even forty grains. In all these cases early vomiting was produced, which, doubtless, removed the strychnin before it was absorbed to a fatal extent. Besides, it is quite possible that the poison was not of full strength.

Fatal Period.—This, like the fatal dose, is liable to con-

siderable variation. Dr. Warner's case terminated fatally in eighteen minutes. Taylor mentions two cases in which death occurred in ten and fifteen minutes respectively; in another case in *five minutes*; in two others in *thirty minutes* each.

On the other hand, life has been prolonged, even after large doses, for several hours. In Cook's case, death occurred in an hour and a quarter after swallowing the pill. In the case of a woman examined by Dr. Reese, death did not occur for six hours after swallowing about six grains of strychnin; morphin, however, had previously been administered. Sir R. Christison reports a case in which a man died in fifteen minutes after swallowing a dose of *nux vomica*.

Treatment.—Prompt and free emesis is of the greatest importance. Copious draughts of warm mustard water, or a mixture of ipecac and zinc sulphate should be given. The stomach-pump may be used if the spasm of the jaws will permit. Chloroform by inhalation appears to have been attended with the happiest results. The patient should be constantly kept under its influence, carefully watching its effects. Potassium bromid has also been given with the best results—sixty to eighty grains every hour or half-hour. Chloral hydrate has also proved an efficient remedy in several cases, and amyl nitrate has been recommended, from its known physiological effects. Atropin has also proved efficacious as an antidote in a case when chloroform failed, and when the paroxysms were very severe.

Two new remedies have lately been suggested as decidedly antagonistic to strychnin—paraldehyde and urethane, both powerful hypnotics; the former by Cervello and

Bokai, the latter by Dr. Coze. Urethane should be given in large doses, from four to six grains, as an antidote. C. G. Williams suggests lutidin as a valuable antidote. He found that when injected into frogs, after a lethal dose of strychnin had been administered, it arrested the convulsions; and if given first, it prevented them.

Dr. Reese experimented on dogs that were poisoned with strychnin, tobacco, iodin, ferric chlorid, and aconite; but in no case did any of these agents exhibit antidotal powers.

Post-mortem Appearances.—These are by no means characteristic, nor are they always similar. Probably the lesions most commonly observed are congestion of the brain and membranes, and of the spinal cord, with engorgement of the lungs and a dark and fluid condition of the blood. The heart is sometimes contracted and empty, and at others full of blood. The rigor mortis is usually prolonged; in one case we found it existing six weeks after death. There is also frequently noticed a livid appearance about the mouth and tongue, and also of the fingers and toes. It should be remembered that certain disorders of the brain and spinal cord, attended with tetanic convulsions, will leave precisely similar lesions to those just referred to as following death by strychnin.

Diagnosis.—The importance of a clear diagnosis in a case of strychnin poisoning cannot be too strongly urged, inasmuch as there may be in such a case a complete absence of all chemical proof. In the celebrated Palmer case this question was most thoroughly sifted on both sides. Indeed, this very case affords an apt illustration of just the sort of difficulties that present themselves in forming a correct appreciation of the symptoms. In the Palmer case the defense brought forward an immense array of diseases,

which, as remarked by Tardieu, "have but a faint resemblance to, and often a complete diversity from, the characteristic phenomena of strychnin poisoning." The only disease whose symptoms can possibly be confounded with those occasioned by strychnin is tetanus in its varieties of idiopathic, traumatic, and hysterical, and possibly some forms of epilepsy.

If the expert were obliged to decide solely from the convulsions—apart from its mode of invasion and seizure, its duration and termination, the condition of the intervals between the paroxysms, in fine, apart from the whole history of the attack—he might probably be unable to discriminate between a case of strychnin poisoning and one of tetanus; but where a careful examination of all these attending circumstances has been instituted there can be no possible difficulty in reaching a satisfactory conclusion. The distinctive characters are the following: (1) In traumatic tetanus the history of the case, as being connected with some injury, such as a lacerated, contused, or punctured wound, involving tendons, nerves, and fascia, will always throw sufficient light on the case to admit of an easy diagnosis; although it must not be forgotten that the most trifling injury, such as the insertion of a splinter of wood beneath the fascia, and which may have entirely escaped recollection, may, after the lapse of several days, give rise to this frightful disorder; and such a case might be mistaken for idiopathic tetanus. But as regards the latter form of the disorder, besides its extreme rarity in temperate climates, its mode of invasion (as likewise that of traumatic tetanus), the duration of the attack and the character of the symptoms, are entirely different from those of strychnin poisoning. In the former there are always manifested certain

prodromes, such as chills, faintness, insomnia, headache, vertigo, and painful tension about the diaphragm, which may last for several days. These, of course, are entirely wanting in poisoning by strychnin, and they never can be mistaken for the general uneasiness which precedes for only a few minutes the sudden outburst of convulsions in the case of the poison. (2) The first symptoms in tetanus are a painful stiffness of the neck and jaws, with a difficulty of moving the head; after this there is a gradual spreading of the rigidity over the muscles of the other parts of the body, usually the trunk first, then the limbs. In some instances the contractions reach their greatest intensity in the course of a few hours; in others, several days may elapse. To contrast this with a case of strychnin poisoning: in the latter, instead of the gradual invasion of the rigid spasms, commencing in the neck or jaws, there is a sudden tetanic seizure of all the muscles of the body simultaneously, producing the violent jerking of the body and the arching of it backward. Again, while the muscles of the neck and jaws are never the first to be affected by strychnin, but are often the last, the reverse is the case in the disease—the trismus being the first indication of its approach. (3) A third distinction is founded on the progress of the two cases; while the violent paroxysm produced by strychnin lasts only from half a minute to one or two minutes, and is succeeded by a complete relaxation, in tetanus, on the contrary, the rigidity is generally permanent, or if there be any remissions these never exhibit the character of the complete intermissions characterizing the action of strychnin. (4) The termination of the cases is widely different; idiopathic tetanus never terminates fatally in two or three hours, but usually several days elapse; while in the case of the poison

death often occurs within half an hour to two hours. Some cases of traumatic tetanus are reported which proved fatal within twelve hours; and one remarkable case, quoted by Watson, of a negro who lacerated his thumb by the accidental fracture of a china dish; he was seized with convulsions almost instantly and died with tetanic symptoms in a quarter of an hour. This can hardly be a case of true tetanus; indeed, it seems unlikely that the symptoms were caused by the accident mentioned.

As regards the hysterical form of tetanus, although its very existence has been denied by some, especially in the male, it is admitted by numerous competent authorities; and, inasmuch as among other forms it may assume that of tetanic spasms, and might occasion doubt under peculiar circumstances, the examiner should ascertain the previous history of the case, which will serve to clear up the diagnosis.

In relation to epilepsy there ought to be no difficulty in the diagnosis; the mode of seizure, the unconsciousness, and the peculiar clonic movements are wholly different from the characteristic tetanic spasms of strychnin poisoning. Again, the deep stupor which terminates an epileptic attack contrasts widely with the complete relaxation and perfect intelligence that follow the strychnin spasm.

Analytic Methods.—Strychnin occurs in the form of a white powder, and also in crystals, usually prismatic. It is almost insoluble in water—one part in seven or eight thousand. Absolute alcohol dissolves one part in about two hundred; amylic alcohol, one in one hundred and twenty; pure ether, one in about fourteen hundred; commercial ether, one in about one thousand; chloroform, one part in eight. It is insoluble in the fixed alkalies, and very

sparingly so in ammonium hydroxid. The salts of strychnin are very soluble in water and alcohol, but very slightly so in ether. The taste is intensely and permanently bitter. This is one of its characteristic qualities. In fact, it is the bitterest substance known. As the result of numerous experiments, Dr. Reese found distinct bitterness yielded by a solution of one grain of strychnin in several gallons of water. This bitter taste is one of the strongest corroborative proofs of the presence of strychnin. Unless the ultimate extract obtained by the manipulation has a bitter taste, one need not expect to prove the presence of the poison by the usual chemical tests. The mere bitterness is not of itself evidence of strychnin, since this quality pertains to numerous other substances, such as morphin, quinin, aloës, colocynth, and picrotoxin.

The strong mineral acids produce no coloration with strychnin, provided the latter is pure; if it contains brucin it will impart a reddish color to nitric acid. Heated on porcelain, it melts slowly into a brown liquid, and is decomposed, giving off dense white fumes and leaving carbon. It may be sublimed by heat, depositing feather-like crystals on a cold glass surface.

1. *The Color Test.*—This is so named on account of the beautiful succession or play of colors that is developed by it. It consists in the application of a drop of pure sulphuric acid to a small fragment of strychnin on a white porcelain surface or on a watch-glass over white paper. If the strychnin be perfectly pure it will dissolve in the acid without any coloration. If now a fragment of potassium dichromate, manganese dioxid, lead dioxid, potassium ferricyanid, or potassium permanganate be stirred in contact with the solution by means of a pointed glass rod, a play of colors

is instantly manifested. At first it is of a rich, deep blue; this soon passes into violet and purple, which, in its turn, fades into a pink, then into a red, and finally into a dirty green.

The relative duration of these shades of color depends on the quantity of strychnin operated on, and also on the relative amounts of acid and the other substance. Thus, if the amount of strychnin be extremely minute, the blue color may flash out but for a moment, leaving only the violet or purple, which quickly passes into the red.

The *principle* involved in the color-test is the action of oxygen (developed by the sulphuric acid on the various oxidizing substances above named) on the strychnin. Allen states that manganese dioxid is the best substance to use in this test.

It is very important to have clear and definite ideas about this color-test for strychnin. It is not the mere production of a blue color that is of diagnostic value, for this might result from the application of potassium permanganate to various organic bodies in the absence of strychnin; but it consists in the regular succession of colors—from blue to violet, pink, and red, the last continuing for some time and ultimately changing to a dirty green. So far as is known, strychnin is the only substance that answers to the above requisition. There are others that react somewhat similarly, which will be noticed hereafter.

The exceeding delicacy of the color-test deserves special notice. If the strychnin be perfectly pure and the manipulation be properly performed, so minute a quantity as the one-millionth of a grain can be detected. Much depends on the manner of the experiment. Minute quantities of strychnin are best obtained by first making a solution of the

alkaloid in pure water, with the addition of acetic acid of a definite strength. This may readily be reduced by the addition of more water. Fractional portions of the solution may be obtained by using a pipette drawn out to a capillary point, which will deposit minute droplets on a warmed, clean porcelain surface. The object here is to concentrate the quantity to be experimented upon into as small a space as possible. The drop should then be carefully evaporated to dryness. A small drop of pure concentrated sulphuric acid is then applied to the deposit by means of a finely-pointed glass rod, and then a minute amount of manganese dioxid (or one of the other oxidizing bodies) is placed alongside of the acid solution, and then, by means of the rod, it is drawn through the solution and gently stirred into it.

Interferences.—As above mentioned, the color-test properly applied will detect exceedingly minute portions of pure strychnin; but there are many organic substances whose presence will considerably modify and even completely disguise this test. This fact has been known to chemists since 1850, when it was first announced by Brieger. His results have been confirmed, and the list of interfering bodies has been extended by subsequent experimenters. According to Lyman, potassium permanganate is the only reagent that will develop the color-test with strychnin when the latter is mixed with either morphin or quinin in excess. The most important of these interferences, considered medico-legally, is probably morphin, inasmuch as this substance might be likely to be given to allay the severity of the strychnin spasms, and would consequently be associated with the strychnin extracted from the body after death. A large number of experiments made by Dr. Reese clearly confirm the fact of the interference of morphin with the usual color-

test for strychnin, both in the pure state and when mixed with organic matters. The important point to establish was that this interference was especially obvious when both alkaloids were present in only very minute quantities, such as the one-hundredth of a grain or less; in such cases the strychnin is not discoverable by the color-test if the morphin is in excess, and is barely manifested when in equal quantity. One experiment by Dr. Reese will be mentioned: A cat was poisoned "with one-twentieth of a grain of strychnin and one-tenth of a grain of morphin. The ultimate extract obtained from the stomach by Stas' process entirely failed to yield the color-test, although the bitterness of the extract and the fact that its solution produced the characteristic tetanic convulsions in a number of frogs distinctly proved the existence of strychnin."

Admitting, then, the fact of these interferences, it is well to remember that practically they may be avoided by the employment of chloroform instead of ether as the proper solvent to extract the strychnin from organic mixtures; morphin and other interfering substances being insoluble in this menstruum.

Fallacies.—Exception has been taken to the color-test on the ground that other substances besides strychnin will yield colors similar if not identical when similarly treated, but a careful attention will readily avoid all difficulty. The substances alluded to are curarin, veratrin, cod-liver oil, salicin, santonin, anilin, narcein, papaverin, and solanin; but in relation to most of these a radical ground of distinction is that they are colored by sulphuric acid alone, which is not the case with strychnin. A salt of anilin is not colored by the acid alone, but only in the presence of one of the above-mentioned oxidizing bodies; but the

former is first colored green, then a persistent blue, and finally black.

Curarin has many points of resemblance to strychnin; it is very bitter; it yields a succession of colors with sulphuric acid and potassium dichromate, but it is much more soluble in water, forms amorphous compounds with potassium dichromate, and is colored purple by strong nitric acid; it is nearly insoluble in chloroform and readily soluble in alkalies. Its physiological effects are the opposite of those of strychnin.

Cod-liver oil, when treated with sulphuric acid alone, affords a play of colors somewhat like those presented by strychnin.

2. *Galvanic Test.*—This acts on the same principle of presenting nascent oxygen to the strychnin, but in this instance it is evolved by electricity. A drop of a dilute solution of strychnin is placed in a small depression made on platinum foil, or in a platinum capsule, allowed to evaporate to dryness, and then moistened with a drop of sulphuric acid. The foil (or capsule) is connected with the positive pole of a single cell of Grove's battery, and the acid is touched with the platinum terminal from the negative pole. Instantly the violet color will flash out on the metal, and on removing the pole from the acid the tint will remain.

3. *Sodium hydroxid or ammonium hydroxid* precipitates the alkaloid from a somewhat concentrated solution in the crystalline form. The best method is to expose a drop of the solution on a glass slide to the vapors of ammonium hydroxid and place it under the microscope; the beautiful formation of the long stellate prismatic crystals can easily be distinguished; these can be identified by touching them

with a drop of sulphuric acid and a small amount of manganese dioxid, when the play of colors will take place.

4. *Potassium Dichromate.*—A solution of this salt throws down from a strychnin solution a bright-yellow precipitate, which soon becomes crystalline. Placed under the microscope these crystals appear in groups mingled with octahedral plates. When dried, these should be verified by touching them with a drop of sulphuric acid, which produces the play of colors. This is a satisfactory test.

5. *Picric Acid.* — A solution of this acid precipitates strychnin from its solution in the form of abundant yellow crystals. The best mode of showing it is to add a drop of the solution to one of strychnin on a glass slide, and view the reaction under the microscope. The precipitate which first forms soon assumes the appearance of tufts of yellow crystals of a peculiar claw-like form. These, as in the former experiment, may be subjected to the color-test by the same method.

Besides the above tests there are others of inferior value, as platinum chlorid, potassium iodid, and potassium thiocyanate.

6. *Physiologic Test.*—The extreme susceptibility of the frog to the action of strychnin was first employed by Marshall Hall as a test for this poison. It may be applied either by immersing a small frog in the strychnin solution or by injecting it into the throat of the animal or, preferably, under the skin. Dr. Reese reports that he has had many satisfactory results with this test. One of these experiments demonstrates very clearly the extreme susceptibility of the frog to the influence of strychnin: "The one five-hundredth of a grain of strychnin was put into the throat of a middling-sized frog; it was convulsed and died in about thirty

minutes. The extract obtained from the stomach by Stas' process, although it afforded no perceptible color-test, had a bitter taste, and produced tetanic spasms in several small active frogs."

Dr. Reese's experiments in this line further demonstrated the fact that while morphin, when present in excess with strychnin in small quantities, has the power to disguise the color-test, it affords no obstacle to the employment of the frog-test. Two experiments may be quoted under this head: "A frog weighing thirty-five grains was immersed in a solution of the strength of one-fourth of a grain of strychnin and eight grains of morphin to one pint of water; it was convulsed in twenty minutes. Another animal, rather smaller, was convulsed in five minutes." (In these experiments only a small portion of the solution was used, less than a fluid drachm, put into a conical glass, in which the hind-quarters only of the animal were immersed.) "A cat was poisoned with one-twentieth of a grain of strychnin and one-tenth of a grain of morphin. The stomach, on examination by Stas' process, failed to yield the color test; but the watery solution of the extract produced most decided tetanic convulsions in eight frogs, generally resulting in death."

The physiologic test, although so important for corroboration, should not be relied on exclusively in the absence of the chemical tests, since several other substances, including some of the ptomaïns, produce somewhat similar symptoms.

Toxicologic Examination.—The stomach properly divided, together with its contents, and a sufficient quantity of distilled water, should be made distinctly acid with pure acetic acid. If the elaborate process of Stas is to be employed,

the strongest alcohol must be used instead of water. In either case the mass should be digested on a water-bath for several hours. A high temperature is objectionable, as it dissolves out the starchy matters. After cooling, it is strained through muslin, and the solid matters washed with dilute alcohol, and pressed. The liquid should next be concentrated by evaporation, and filtered through paper. It should now be evaporated to dryness. The residue will contain any strychnin that may be present, in the form of acetate, mixed with organic matter. This residue should now be thoroughly mixed with a small quantity of distilled water containing a few drops of acetic acid, then filtered through paper, and the filtrate shaken up successively with ether, benzene, chloroform, and amylic alcohol, which will remove many impurities, but will not dissolve the strychnin in the acid solution. It is then poured into a glass tube or flask, and an excess of sodium carbonate or ammonium hydroxid added, which liberates the strychnin. Pure chloroform, slightly in excess of the mixture, is now added, and the whole briskly shaken together for some minutes. Blyth recommends to add the chloroform before the alkali ; the strychnin is more soluble before it assumes the crystalline condition. The chloroform dissolves out the alkaloid, and collects at the bottom of the mixture after the lapse of some time.

To separate the chloroform from the supernatant liquid the easiest practical method is to transfer the whole mixture to a stoppered glass funnel, or, what answers equally well, a glass syringe of proper size after removing the piston, and having previously contracted the nozzle to a fine point by means of the flame. Before introducing the liquid, this small aperture should be plugged with a splinter

of wood, and about half a drachm of pure chloroform first poured into the syringe, so as to about fill the narrow portion. The mixture is now to be carefully poured in and a sufficient time allowed to elapse for the chloroform to separate and settle to the bottom. By placing the thumb over the larger aperture of the syringe, and withdrawing the wooden plug, it will be very easy to control the flow of the contents. A few drops may be allowed to fall successively, as each one dries, into a warmed watch-glass or porcelain capsule, for a trial by the color-test. The whole of the chloroform is then permitted to flow out into one or more capsules or watch-glasses, great care being taken not to allow any of the other mixture to escape along with it. The remaining alkaline liquid may be shaken up with an additional portion of chloroform, and the separation again made as before. All the chloroform is now permitted to evaporate spontaneously to dryness. The contained strychnin, if of notable quality, will usually be found in the deposit in an amorphous form.

As a trial-test, a portion of this extract should now be examined by the taste for bitterness; by the color-test (although this may not be very satisfactory, on account of the mixture with organic matter); and by the frog-test. The remaining portion of the extract is to be dissolved in a minute quantity of water, acidulated with acetic acid, filtered and subjected to the usual tests.

The main difficulty in conducting this experiment arises from the presence of organic matters in connection with the strychnin. If the chloroform extract has a yellow color (denoting its impurity), a few drops of strong sulphuric acid should be added to it and thoroughly stirred with a glass rod and gently heated. This blackens, destroys, and car-

bonizes the organic matter and converts the strychnin into a sulphate; add a few drops of water. After standing a short time the dark liquid is filtered, sodium carbonate or ammonium hydroxid added in excess, then pure chloroform, as explained above. The second extract thus procured is generally sufficiently pure for all practical purposes.

It not unfrequently happens, when operating on complex organic mixtures by the chloroform process, that difficulty is experienced in getting the chloroform to separate from the alkaline solution, the whole mass forming a sort of emulsion. In such a case the tube may be immersed in hot water for some time, and if this does not answer, nothing remains but to agitate the mixture several times successively with about half its volume of pure water, allowing it to rest each time, and separating the chloroform as before directed. The separation can often be promoted by the use of a centrifugal machine. The mixture is slightly acidulated by acetic acid, then transferred to a small dish, and evaporated to dryness on a water-bath; the residue is stirred with a very small quantity of pure water; the solution is filtered, rendered slightly alkaline, and again agitated with fresh chloroform, which usually will readily separate.

The method of dialysis has been recommended by some authorities, but does not seem to be as satisfactory as the one just described.

Detection in the Tissues and Blood.—Strychnin is absorbed into the circulation and deposited in the various organs, just like the mineral poisons. The *rapidity* with which the absorption takes place is shown in a case mentioned by Taylor, where a man took five grains of the poison by mistake, and died in half an hour. Strychnin was discovered in the stomach in the quantity of one grain; it was

also detected in the liver and tongue. This case shows that within half an hour four-fifths of the poison had been removed from the stomach (or could not be detected there by chemical research), and had been diffused throughout the body. There are, however, other cases where the circumstances were apparently just as favorable for the absorption and diffusion of the poison, but where there was a total failure to detect it in the organs after death.

The process is the following: The organs are to be finely crushed and digested in strong alcohol, acidulated with sulphuric acid in the proportion of eight drops to the fluid ounce of the mixture; this should be heated below 212° F. for about an hour; when cool, it is to be filtered and concentrated, as before directed. The residue is then nearly neutralized by sodium hydroxid, care being taken to maintain an acid reaction, then filtered and evaporated nearly to dryness. To the cooled residue a drachm or two of strong alcohol is added and thoroughly stirred with it; this dissolves out the strychnin sulphate, and leaves the potassium sulphate and the organic matters. The alcoholic solution is now filtered, evaporated almost to dryness, the residue stirred with pure water, rendered alkaline by sodium hydroxid, and finally agitated with chloroform, which deposits the alkaloid, if present, on evaporation.

Dr. Taylor recommends acetic acid and ammonium hydroxid in these cases.

The method of Rodgers and Girdwood is somewhat similar; they employ hydrochloric acid and ammonium hydroxid as the reagents along with chloroform.

Strychnin may be recovered from the blood by a similar process. In some experiments of Wormley the poison was detected in the blood of dogs and cats, where death

took place in three and six minutes respectively after its administration. This shows the extreme rapidity with which it is absorbed.

Detection in the Urine.—The urine should be evaporated to a syrupy consistence, acidulated with acetic acid mixed with an ounce of strong alcohol, filtered and evaporated to near dryness. The residue is to be stirred with pure water, filtered if necessary, sodium hydroxid added in excess and agitated with chloroform.

Failure to Detect.—It must be admitted that the most careful analysis sometimes fails to discover this poison in the body after death, and that, too, where the circumstances were apparently favorable to it. This failure may sometimes be ascribed to the smallness of the dose, and again possibly to some interference—probably some ptomaïn, especially when there is putrefaction ; though mere putrescence of the body is of itself no obstacle to its detection, since it has been recovered months after death, and where the body was in an advanced state of decomposition. Allen has reported a case in which strychnin was found in organic matter after seven years. Dr. Leffmann found it in vomited matter which had been kept for nine years. Christison, Taylor, and other well-known authorities have at times been foiled in their efforts to detect the poison. In a case that Dr. Reese examined some years ago, in which a woman was poisoned it was alleged with six grains of strychnin, and in which death was postponed for the unusually long period of six hours, there was a similar failure to detect the poison eight weeks after death, although the body was well preserved. In this case (as already mentioned) morphin had also been administered, which may have interfered with the usual color-test.

Brucin.—This alkaloid is generally found associated with strychnin. It occurs either in the form of a white powder or in colorless prismatic crystals. It is more soluble in water and alcohol than strychnin. It is freely soluble in chloroform and alcohol. It has an intensely bitter taste. Concentrated sulphuric acid dissolves it, giving a faint rose coloration. It does not respond to the color-test of strychnin. Nitric acid gives a characteristic blood-red color.

Its poisonous properties are similar to those of strychnin, though much less intense. As the symptoms of poisoning by it are similar to those caused by strychnin, the toxicologist should guard against being deceived in a medico-legal investigation, in the event of not discovering strychnin by the usual color-test. In such a case it would always be proper to search for brucin.

Tests.—(1) The characteristic reagent is nitric acid, which instantly produces a blood-red color with a speedy solution of the alkaloid. If heated the color changes to yellow. If after cooling a drop of the solution of stannous chlorid be added, the color changes to a beautiful purple. The somewhat similar red color produced on morphin by nitric acid is not changed by protochlorid of tin.

(2) *Sulphuric Acid and Potassium Nitrate.*—Touch the fragment of brucin with a drop of strong sulphuric acid, and a faint rose color is produced; then add a small crystal of potassium nitrate, when the color changes to a deep orange-red.

(3) *Ammonium hydroxid* produces with a drop of brucin solution a beautiful crystallization, viewed by the microscope.

Blyth regards methyl iodid as the best test for brucin.

If it is added to a strong alcoholic solution of brucin, circular rosettes of crystals appear. This test does not act with strychnin.

The frog-test is equally applicable to brucin, allowing for its comparative inferiority in strength to strychnin.

The *toxicologic examination* for brucin is conducted in the same manner as described for strychnin. The ultimate extract is to be tested by nitric acid and stannous chlorid. Brucin has been detected in the blood of animals poisoned by it.

CEREBRO-SPINAL NEUROTICS.

A subdivision of Cerebro-spinal Neurotics has received the name of *Deliriants* because of the active delirium that constitutes one of their prominent symptoms. They also produce other effects in common, such as illusion of the senses, dilatation of the pupil, heat and dryness of the throat, a flushed face, and frequently a redness of the skin. They all belong to the same natural order of plants, *Solanaceæ.* From their physiological property of dilating the pupil they have received the name of *Mydriatics.* They comprise Belladonna, Stramonium, Hyoscyamus, and different species of Solanum.

BELLADONNA.

Belladonna (*Deadly Nightshade*).—The leaves, berries, and root of *Atropa belladonna* are violently poisonous. The leaves and root are used in medicine. Children are frequently poisoned by eating the berries.

Symptoms.—A sense of heat and dryness in the mouth and throat, difficulty of swallowing, nausea, vomiting, giddiness, extreme dilatation of the pupil, loss of vision,

flushed face, sparkling eyes, delirium of an excited, maniacal character, spectral illusions, convulsions, followed by stupor and coma. Irritation of the urinary organs frequently occurs, such as strangury, suppression of urine, and hematuria. A scarlet eruption is often observed over the skin. Some of these effects have been produced by the external application of belladonna in the form of a plaster or liniment. The symptoms of belladonna poisoning usually show themselves in from half an hour to two hours, occasionally sooner; they do not generally terminate fatally. Death when it occurs usually takes place within twenty-four hours.

In case of death from the leaves or seeds of belladonna, these can usually be distinguished in the alimentary canal by their botanical characters, as shown by the microscope.

Atropin.—This alkaloid is the active principle of belladonna and is a very powerful poison, producing symptoms similar to those above described, only more speedily. The application of a weak solution to the eyes has occasioned symptoms of belladonna poisoning. Used hypodermically, even in doses of one-fiftieth to one-tenth of a grain, it occasions at times violent symptoms. Employed in this manner in combination with morphin in excess its activity appears to be modified. Death has resulted from the external use of a strong ointment of atropin.

Fatal Dose.—One-half to three-quarters of a grain may be regarded as a minimum fatal dose for an adult. The criminal administration of this poison is very rare. Taylor records a case where a surgeon of a workhouse was fatally poisoned by a nurse by administering it in milk. The diagnosis is not always easy, since the same symptoms are pro-

duced by hyoscyamus and stramonium. There appears to be a special tendency to its elimination from the system by the kidneys. Guy states, on the authority of Harley, that the presence of atropin in the urine can be readily proved within twenty minutes after the injection under the skin of one-forty-eighth to one-ninety-sixth of a grain by the action of the urine on the eye. Twelve drops will largely dilate the pupil and maintain it in that state for several hours.

Treatment.—The immediate evacuation of the stomach by an active emetic or by the stomach-pump. There is no chemical antidote. The physiological antidote is morphin, which should be carefully and repeatedly administered. The subcutaneous injection of pilocarpin has been found very effectual by Ringer and others.

Post-mortem Appearances.—These are not characteristic. There may be congestion of the vessels of the brain, with some red patches of the stomach and esophagus. When the poisoning has resulted from eating the ripe berries, the whole lining membrane of the alimentary canal may be dyed of a purple color, and portions of the berries and seeds may be discovered in the intestines or in the stools. The blood is usually fluid and dark-colored.

Analytic Methods.—Atropin, when pure, occurs in white crystalline tufts. Its taste is acrid and bitter; slightly soluble in cold water, very soluble in alcohol, ether, and chloroform. It sublimes at 200° F. Its color is not changed by either of the mineral acids. It has alkaline properties, neutralizing acids and forming salts. If a minute quantity be evaporated to dryness with a few drops of a solution of barium hydroxid, and heated strongly, an odor is evolved resembling that of hawthorn (Blyth).

Sodium hydroxid throws down from solutions of atropin salts a precipitate which ultimately becomes crystalline. That produced by ammonium hydroxid remains amorphous. It is also precipitated by gold chlorid and by picric acid. Iodin in potassium iodid gives a reddish-brown precipitate with a very minute portion, but this is not characteristic. Wormley considers bromin in hydrobromic acid to be the characteristic test for atropin. The precipitate is at first amorphous, of a yellow color; but it soon becomes crystalline. It is insoluble in acetic acid, and but slightly so in either of the mineral acids. The one-ten-thousandth to one-twenty-five-thousandth of a grain will give satisfactory results with this reagent.

Another delicate test is that of Vitali. A small portion is covered with a little fuming nitric acid, and dried on a water-bath, and when cold is moistened with a drop of a solution of potassium hydroxid in absolute alcohol; a violet color is instantly produced, which soon passes into a fine red.

Free atropin, as obtained by evaporating its chloroform or ether solution (after liberation of the alkaloid from one of its salts by ammonium hydroxid), gives a red color with phenolphthaleïn. This reaction is common to hyoscyamin and hyoscin, and is also produced by the artificial base homatropin, but is not given by any other alkaloid in common use (except, according to Plügge, the volatile bases conin and nicotin). Flückiger, who first observed the peculiar behavior of the tropeïnes with phenolphthaleïn, recommends that a minute quantity of the alkaloid to be tested should be placed on phenolphthaleïn paper (this should be freshly prepared), which is then wetted with strong alcohol. No coloration will be produced at first,

but on allowing the alcohol to evaporate, and touching the alkaloid with a drop of water, a brilliant red coloration will appear. On adding alcohol the color is destroyed but appears again as the spirit evaporates.

Toxicologic Examination.—We should first of all endeavor to discover any seeds or remains of the leaves or berries of the plant. The vomit and stools should, if possible, be also examined for these. The stomach with its contents, and other organs properly comminuted, should be treated after a modification of Stas' process, alcohol being used as the solvent, along with sulphuric acid. After heating, straining, evaporating, purifying by pure ether or amyl alcohol, removing the ether, and adding solution of potassium hydroxid in excess, the ultimate extract is obtained by chloroform, and tested first with the bromin test, which, if successful, may be followed by the other tests.

The physiological test consists in applying a portion of the ultimate extract to the eyes either of a man or one of the lower animals, as the rabbit. The minutest quantity will produce the characteristic dilatation of the pupil. It must, however, be remembered that other members of this class of alkaloids will produce a similar result, and that mydriatic ptomaïns may be extracted from decomposed tissues.

The rabbit evinces a remarkable tolerance for belladonna and its alkaloid. It will live exclusively on the former for many days, and tolerate enormous doses of the latter, either by the stomach or subcutaneously, without perceptible effects.

STRAMONIUM, HYOSCYAMUS, AND SOLANUM.

Stramonium (*Thorn Apple, Jamestown Weed*).—The *Datura stramonium* is a common plant, abounding in this country and also in Europe. It grows freely on waste grounds; other varieties occur in India. All parts of the plant are poisonous, especially the seeds and fruit. Its active alkaloid principle has been called daturin, but is now regarded as identical with atropin.

Cases of poisoning by stramonium are usually accidental, and chiefly occur in children from eating the seeds.

Symptoms.—Very similar to those produced by belladonna, such as dryness of throat, with difficulty of swallowing, dilated, insensible pupil, violent and incoherent delirium, nausea, vomiting, headache, vertigo, ringing in the ears, spectral illusions, followed by stupor and coma. Sometimes there are convulsions and paralysis, together with a scarlet efflorescence on the skin. The external application of the bruised leaves has occasioned symptoms of poisoning.

In India, a species of datura is employed by the Thugs for the purpose of drugging their victims.

Post-mortem Appearances.—Very similar to those resulting from belladonna. There is nothing characteristic. The seeds and remains of the leaves may be discovered in the alimentary canal, if these have been the cause of death.

Treatment.—The same as that recommended for belladonna poisoning.

Analysis.—The seeds are of a black or brown color, kidney-shaped, with a wrinkled surface. They are much larger than those of belladonna or hyoscyamus. According to Guy, it requires one hundred and twenty henbane seeds

and ninety of belladonna to weigh one grain, but only *eight* of stramonium.

The method of procuring the alkaloid from the stomach and organs is the same as that above described for atropin.

Hyoscyamus (*Henbane*).—The *Hyoscyamus niger* grows both in America and Europe. All parts are poisonous. The root is tapering, resembling that of the parsnip, for which it has often been mistaken. The medicinal preparations from the plant are extremely variable and uncertain, depending very much on the mode of growth, collection, and preparation.

The *symptoms*, in general, resemble those of belladonna and stramonium.

Analysis.—It can only be identified in the matters vomited, or in the stomach and intestines after death, by the botanical character of the seeds, or fragments of the leaves discovered.

Hyoscyamin, the alkaloidal principle, forms in white, silky crystals, inodorous when pure, but is usually found possessing a disagreeable smell; taste acrid. It is difficult to isolate. There is no special chemical test for it. It dilates the pupil, like atropin. It speedily passes into the urine when swallowed.

Solanum.—Three species of the genus *Solanum* are usually referred to in the books as possessing poisonous properties; these are *S. dulcamara*, Bittersweet or Woody Nightshade; *S. nigrum*, Garden Nightshade; and *S. tuberosum*, Common Potato. These all contain a substance called solanin.

The *S. dulcamara* is cultivated in gardens as an orna-

ment. Its berries are sometimes eaten by children, occasioning poisonous results. The dried stems are used medicinally.

The *S. nigrum* produces white flowers and black berries. The latter, like the fruit of the *S. dulcamara*, have frequently proved poisonous to children who have swallowed them. They are more powerful in their effects than the others.

S. tuberosum is the common potato. The berries and young shoots have proved poisonous, the former fatally in the case of a young girl. Christison quotes an instance in which four persons of a family were seized with alarming symptoms, such as vomiting, coma, and convulsions, after eating potatoes that had commenced to sprout and shrivel.

The general symptoms produced by solanin are very similar to those resulting from the mydriatics. It is much less powerful than the other bodies of this class.

When pure, solanin is in the form of delicate acicular crystals, nearly insoluble in water, soluble in alcohol, less so in ether, insoluble in chloroform. It is also soluble in amylic alcohol. The hot solution in the latter has the property of gelatinizing on cooling, even in so small a quantity as one part in a thousand. Cold sulphuric acid first changes it into an orange-yellow, and then dissolves it, the solution becoming brown. Nitric acid dissolves it, the solution being at first colorless, and subsequently changing to a rose-red tint. The former acid is the best test for it. Other reagents do not give characteristic results.

Solanin is separated from organic mixtures by a modification of Stas' process; alcohol and sulphuric acid being employed as the solvent, and warm alcohol to separate the final extract.

Cocain.—This is a crystalline alkaloid, found in the leaves of the *Erythroxylon coca*. It is colorless; has a bitter taste; is nearly insoluble in water and alcohol; soluble in ether. In small doses it is a cerebral, cardiac, respiratory, and nervous stimulant. Overdoses produce great embarrassment of the heart and lungs, the pulse becoming small, rapid, and intermittent; respiration slow and feeble. Death occurs from spasm of the heart and muscles of respiration. It also occasions delirium and hallucinations, and likewise dilates the pupils, whether taken internally or externally. It is sometimes taken to correct the morphin habit, but is very apt to substitute its own habit upon the unfortunate patient.

Cocain is valuable as a local anesthetic in from 4 to 10 per cent. solutions, as an application to painful affections of the nose, ear, and throat; also in minor surgical operations. This local application sometimes produces dangerous symptoms; in one case so small an amount as two-thirds of a grain produced death. There is no proper antidote; morphin is perhaps the best physiologic remedy. Cocain resembles atropin in its general action, especially in its influence on the pulse, respiration, pupils, sweat glands, and bowels.

What is termed the cocain habit is marked by insomnia, loss of digestive power, enfeeblement of mind, emaciation, hallucinations, delirium, and general loss of health—a condition much resembling the worst effects of opium.

Cocain is usually employed in the form of hydrochlorid. It is contained in many of the preparations now used for producing local anesthesia in the extraction of teeth. A small amount of phenol is also often present in these liquids.

The most striking tests for cocain or its salts in aqueous

solution are the crystalline precipitates produced by gold chlorid, platinum chlorid, and picric acid. Iodin in potassium iodid produces a rose-colored precipitate in very dilute solution, and a brown one in stronger solutions, which is not crystalline. When cocain is subjected to Vitali's test (see under atropin), a distinct odor of peppermint or citronella is noticed.

Recently several artificial substances, analogous to cocain in composition and properties, have been introduced into medical practice, especially as local anesthetics. Among these is eucain. It is sold principally in the form of hydrochlorid. Little is known as yet as to its toxicology.

Several of the cerebro-spinal neurotics are conveniently classified as depressants, because they produce great depression of the muscular system, though they differ materially in other respects.

TOBACCO AND LOBELIA.

Tobacco is the dried leaves of *Nicotiana tabacum*, a plant belonging to the natural order of *Solanaceæ*. It owes its activity and poisonous properties to a volatile oily alkaloid (nicotin), which somewhat resembles conin, and which exists in different proportions in different specimens of the leaves, varying from two to eight per cent.

Symptoms.—A large dose of tobacco (or even a small one to those unaccustomed to its use) produces very decided symptoms. Very soon after taking it, either by swallowing or enema, it occasions nausea, giddiness, a sense of confusion of the head, vomiting, severe retching, great prostration, heat in the stomach, frequent and very feeble pulse, cold, clammy skin, trembling of the limbs, and sometimes severe purging. Respiration is difficult, and urination in-

voluntary. In some cases there is violent pain in the abdomen; in others there is a great sense of depression and of impending death. Convulsions of a tetanic character sometimes occur. The pupils are not always similarly affected. Taylor states that they are dilated. Percival speaks of it as differing from belladonna in contracting them; also by the absence of delirium and of dryness of the throat. Wharton and Stillé state that the pupils are but slightly affected.

The external application of tobacco, either to the sound skin or to abraded surfaces, produces alarming and even fatal effects. A wet leaf put around the throat in spasmodic croup often relieves the spasm, but it should be used with great caution on a young child. A decoction applied to the skin of a man for an eruptive disease caused death in three hours.

Its fatal effects, when administered by the rectum, are well known. It was formerly much used in this manner to aid the taxis in strangulated hernia, but it is always a dangerous remedy. Even tobacco smoke, diffused through water and swallowed, has caused the death of a young infant.

Tobacco smoking has been known to produce violent and even fatal effects when carried to great excess, although there is considerable diversity of opinion as to whether nicotin is present in tobacco smoke or not. Authorities are found on both sides.

The rapidity of the effects of tobacco on the human system varies with the dose and mode of administration. In one case snuff swallowed in whisky caused death in one hour. In another instance, quoted by Beck, an enema of tobacco, used to expel worms, produced violent convul-

sions and death in fifteen minutes. Christison gives another case where a tobacco enema proved fatal in thirty-five minutes. The application of nicotin to the tongue of an animal caused death within two minutes.

Post-mortem Appearances.—There is no characteristic lesion. A diffused redness over the mucous surface of the stomach and bowels, with an empty heart and congestion of the vessels of the brain, liver, and lungs, are about all that will be found. The blood is usually very dark and liquid. If the leaf or powder has been swallowed, these may be recognized by microscopic examination. In a case of suicide Taylor found general relaxation of the muscular system, staring eyes, bloated and livid features, the vessels of the brain and scalp and also of the lungs gorged with black blood, and the heart empty except its left auricle. There was intense congestion of the mucous membrane of the stomach and of the liver. The blood was liquid, and in some parts had the consistence of treacle. No peculiar odor was perceptible.

Nicotin.—This alkaloid when pure is a colorless, oily liquid which, on exposure, becomes light yellowish and thicker in consistence. It produces a greasy, volatile stain on paper, like conin. It is usually said to possess an acrid, unpleasant odor, but if perfectly pure the smell is ethereal and agreeable. It has a strong, alkaline reaction and a density of 1.0111. It is freely soluble in water, alcohol, ether, chloroform, turpentine, and the fixed oils. Ether and chloroform will extract it from its watery solution. Its taste is very pungent and acrid, even when much diluted, causing a peculiar sensation in the throat and air passages. It slowly distills at about 295° F., and boils at about

470° F. Heated on platinum it burns with a bright flame, emitting a thick black smoke.

Nicotin is one of the most rapidly fatal poisons known, even rivaling prussic acid. A single drop destroyed a rabbit in three and a half minutes. In Wormley's experiments one drop placed in the mouth of a full-grown cat produced immediate prostration, continued convulsions, and death in seventy-eight seconds.

In the celebrated case of Count Bocarmé, who was executed in Belgium, 1851, for poisoning his brother-in-law, Gustave Fougnies, nicotin was the agent used. An unknown quantity was forcibly put into the throat of the victim, the Countess assisting her husband as an accomplice in the murder. Death was believed to have taken place within five minutes. The poison was detected by Stas in the tongue, throat, stomach, liver, and spleen of the deceased, and also from stains on the floor near where the act was committed. From the excellent report of the examination of Stas, we may note the following particulars: The appearance of the tongue indicated the action of some highly acrid agent; it was swollen, blackened, softened, and friable; the epithelium was easily detached. This was also the condition of the mucous lining of the mouth and pharynx; it was reddened as if cauterized, and easily separated. The lining membrane of the stomach was intensely injected, exhibiting large patches which were livid and black. The vessels were filled with a black coagulum resembling blood that had been treated with sulphuric acid. The duodenum was also highly injected. There were no ulcerations or perforations of the stomach and bowels. The lungs were gorged with black blood and exhibited the usual character of asphyxia. The heart was normal; its

cavities contained black, liquid blood. No odor was observed in the body.

Analytic Methods.—If a drop be put into a watch-glass, and this be covered with another glass inverted, containing a drop of either nitric or hydrochloric acid, the glass will become filled with white fumes, not so dense as from conine, nor do they give rise to the formation of crystals. The strong acids applied directly to it produce no characteristic effects.

Nicotin unites freely with acids, forming salts, which do not readily crystallize, retaining the peculiar taste of the alkaloid, but are destitute of odor. They are mostly soluble in water and alcohol, but not in ether or chloroform.

(1) Platinum chlorid throws down a yellow precipitate, which becomes crystalline seen under the microscope, and is soluble in hydrochloric acid.

(2) Mercuric chlorid gives a white crystalline precipitate, changing to yellow. These crystals assume a peculiar, beautiful appearance in groups of various patterns. These are distinguished from the precipitates caused by this same reagent with ammonium hydroxid and the other alkaloids, by the fact that the latter are amorphous, except that of strychnin, but which last is wholly unlike that produced by nicotin. This is a very delicate test.

(3) Gold chlorid yields a yellow amorphous precipitate, which is not characteristic.

(4) Picric acid gives a yellow amorphous precipitate, which ultimately assumes the form of a crystalline tuft, to be viewed by the microscope.

(5) By adding to an ethereal solution of nicotin a solution of iodin in ether, beautiful long, needle-like crystals form after some hours.

Toxicologic Examination.—The stomach and other organs, properly prepared, may be subjected to the process of Stas. In fact, it was the process employed by its originator in the Bocarmé case above alluded to. Other good authorities have somewhat simplified his process. Water may be employed as the solvent, instead of alcohol ; and either acetic, sulphuric, or tartaric acid may be used. After proper concentration and filtration it should be super-saturated with sodium hydroxid and shaken up with chloroform or ether, and these solutions, when properly separated, allowed to evaporate spontaneously on watch-crystals, when the nicotin, if present, will be seen in the form of drops or oily streaks, having the peculiar odor of the alkaloid, which is rendered more distinct by heating. This should be dissolved in a few drops of water and the appropriate tests applied. A drop or two may also be given to a small animal. Nicotin inserted under the skin of a frog produces peculiar muscular movements, attended with tetanic convulsions, slowing of the heart's action, and of respiration.

It causes death most probably by paralyzing the respiratory nerve centres.

Nicotin has been detected in the tissues several months after death. Wormley procured it from the blood of two cats, each poisoned by a drop placed upon the tongue, the animals having died in seventy-five seconds and in two and a half minutes, respectively.

A ptomaïn has been discovered possessing many of the properties of nicotin, but it is not poisonous, nor does it respond to the usual tests of nicotin.

Lobelia.—The *Lobelia inflata*, or Indian Tobacco, is a native of this country, belonging to the natural order

Lobeliaceæ. It is extensively used both here and in Great Britain in proprietary and domestic medicine. According to Letheby, thirteen cases of poisoning by this substance had occurred in England within three or four years, and Beck states that "thousands of individuals in the United States have been murdered by the combined use of capsicum and lobelia administered by the Thomsonian quacks." The leaves and seeds are the parts employed. They owe their activity to a fixed alkaloid named lobelin.

Symptoms.—In small doses lobelia acts as an expectorant, in large doses as an emetic and depressant. In poisonous doses it produces distressing nausea and vomiting, sometimes purging, extreme relaxation, cold sweats, small, feeble pulse, great prostration, contracted pupils, stupor, occasionally convulsions, coma, and death—symptoms strikingly like those caused by tobacco. A drachm of the powdered leaves has proved fatal.

The *post-mortem appearances* are very similar to those caused by tobacco.

Lobelin, the active alkaloid principle, is a yellowish liquid, lighter than water, of a somewhat aromatic odor, and acrid, persistent taste; soluble in water, more so in alcohol and ether; has an alkaline reaction, forming soluble salts with acids. Tannin precipitates it from its solutions. It resembles nicotin in most of its properties. On animals, lobelin seems to produce the narcotic, but not the emetic effects of the plant.

No case is recorded of death from lobelin. In the investigation of a case of death from lobelia the diagnosis would be materially aided by the discovery of fragments of the leaves or of the seeds.

SPOTTED HEMLOCK.

The *Conium maculatum*, or spotted hemlock, is believed to be the same plant as the *Cicuta* of the ancient Greeks, that furnished the poison by which Socrates perished. All parts are poisonous; the leaves and root are employed in medicine, in the form of fresh juice and extract. It belongs to the natural order *Umbelliferæ*, which also includes many other poisonous plants.

Poisoning by hemlock is generally the result of accident, the fresh leaves being used in soup in mistake for parsley, which it somewhat resembles. Its action on man appears to be very variable—at least the accounts are very diverse.

Symptoms.—Headache, imperfect vision, dilated pupils, difficulty of swallowing, drowsiness, a tingling sensation along the muscles, gradually complete paralysis of the extremities; this extends finally to the muscles of respiration, and the patient dies, at last, from apnea. If death be delayed for some time, there may be convulsions, coma, violent delirium, accompanied with salivation, and involuntary discharges from the bladder and bowels. Death usually takes place in one to three hours. One drop of conin is considered to be a poisonous dose. The treatment consists in a prompt evacuation of the stomach by emetics or the use of the stomach-pump, followed by castor oil and stimulants.

Post-mortem Appearances.—These are not at all characteristic, redness of the mucous membrane of the stomach and congestion of the lungs being usually observed. Fragments of the leaves and the seeds (if these have been swallowed) may often be recognized in the stomach and bowels with the aid of the microscope. If the leaves be rubbed in

a mortar with sodium hydroxid, they emit a peculiar mousy odor.

Conin.—This alkaloid exists most abundantly in the seeds. It is one of the most powerful and fatal poisons known. Christison states that a single drop, applied to the eye of a rabbit, killed it in nine minutes; and three drops, applied in the same manner, killed a strong cat in a minute and a half. In Wormley's experiments, a single drop placed upon the tongue of a large cat caused the animal at first to stand still; in two minutes and a half it fell upon its side, voided urine, had violent convulsions of the limbs, with trembling of the body, when it died in three minutes from the time of administration.

Treatment.—Prompt emesis, to get rid of the poison, and active stimulation. Strychnin has been suggested as a physiological antidote, but it is too dangerous a substance to be employed for this purpose without excessive care.

Properties.—Conin is a colorless, volatile, oily liquid; sp. gr., 0.886; the odor is peculiar, repulsive, and suffocative. Diluted with water it emits an odor resembling mice. It gives a greasy stain to paper, and burns with a bright, smoky flame; taste, disagreeable and permanent. It is a strong base, forming with acids crystalline salts. Exposed to the air it becomes yellowish and resinoid. It is partially soluble in water, freely so in alcohol, ether, and chloroform; the two latter will separate it from its aqueous solutions.

Tests.—A drop is placed in a watch-glass and covered over with a precisely similar glass, holding a drop of pure hydrochloric acid on its under surface; both glasses immediately become filled with dense white fumes, and the drop of conin is converted into a mass of beautiful, delicate crys-

talline needles, which do not deliquesce in the air. Sulphuric acid imparts to it a pale-red color. Nitric acid causes with it dense white fumes. Strong hydrochloric acid imparts to it a faint tint, which gradually becomes much deeper, and on evaporation needle-shaped crystals appear. Like other alkaloids, it yields precipitates with tannin, mercuric chlorid, gold chlorid, platinum chlorid, potassium iodid, etc. By oxidation, conin is converted into butyric acid. A crystal of potassium dichromate is put into a test-tube with some diluted sulphuric acid, together with the suspected conin. On heating, the peculiar odor of butyric acid is revealed. Another test is alloxan. If dropped into a solution of this substance, an intense purple-red color is developed, and white needle-shaped crystals appear. Its liquid, oily condition, together with its peculiar odor, will distinguish it from all other bodies except nicotin ; and the points of difference between the two are mentioned in the article on nicotin.

Toxicologic Examination.—Search first for any remains of leaves, or of seeds, in the stomach and intestines, and avoid mistaking the leaves of parsley for those of hemlock. Rub the leaves in a mortar with potassa, to develop the peculiar mousy smell. Then distill, and examine the distillate before employing the more elaborate process of Stas. Water and acetic acid may be employed as the proper solvents ; evaporate the filtered solution to a syrupy consistence, mix with strong alcohol and a few drops of acetic acid, filter again and evaporate to near dryness ; add a little distilled water, supersaturate with solution of sodium hydroxid, and agitate with ether, repeating the process several times. Remove the ether and allow it to evaporate spontaneously. Dilute the alkaloid and subject it to the appropriate tests.

A conin-like ptomaïn has been discovered, having very poisonous properties, but differing from conin in its reactions.

It is necessary to guard against too much reliance upon the supposed *odor* of conin. Sodium hydroxid may often develop an odor from organic substances which might possibly be mistaken for that of conin. Nothing short of the isolation of this principle, in a search for the poison, will be satisfactory.

Other hemlocks, viz., *Cicuta virosa*, or water hemlock, and *Œnanthe crocata*, are all very poisonous; this is especially true of the *Œ. crocata*, which is one of the most poisonous of the Umbelliferæ. Children are occasionally poisoned by wild Umbelliferæ, the exact species being frequently uncertain, partly because early growths of these plants rarely possess characteristic features, and partly because it is often impossible to secure specimens or clear descriptions of the plants eaten. The common parsnip, *Pastinaca sativa*, and even the common carrot, *Daucus carota*, are abundant in the wild state and are suspected of being more poisonous than in the cultivated forms. The tree known as hemlock (hemlock-spruce) has no botanical resemblance to water-hemlock and is not poisonous.

ACONITE.

Aconite.—The *Aconitum napellus* (Monkshood or Wolfsbane) is indigenous in Europe, but is cultivated in this country. It grows from two to four or five feet high, and has a spike of rich blue flowers. All parts of it are poisonous, the root most so, depending on the presence of the alkaloid aconitin. The root is tapering, carrot-like, two or three inches long,

having a number of curly fibres passing off from it. This root has frequently been mistaken for the root of the horse-radish, from which, however, it differs essentially in appearance; the latter being long and cylindrical and truncated, not tapering, of a light-brown color externally, white internally, and of a sweetish, hot, and pungent taste, totally distinct from that of aconite, which imparts to the lips, tongue, and fauces a peculiar tingling, numbing sensation, which is very persistent.

There is considerable diversity in the activity of different specimens of aconite, depending, doubtless, on the time and modes of collecting and drying of the plant, and probably also on the place of growth. This may account for the discordant results obtained by different investigators.

Aconite root has been administered criminally in at least one recorded case, where the powdered root was mixed with pepper, and sprinkled over the greens used for dinner by the deceased.

Symptoms.—There is first a dryness of the throat, accompanied with tingling and numbness of the lips, throat, and tongue, followed by nausea and vomiting, with pain and tenderness of the epigastrium. The numbness and tingling now become more general, with diminution or loss of sensibility of the surface, vertigo, dimness of vision, tinnitus aurium, with occasional deafness, frothing at the mouth, sense of constriction of the throat, great muscular prostration, inability to walk, a slow, feeble pulse, difficulty of breathing, a cold, clammy skin, dilated pupils, features pale, perhaps a few convulsions, followed by death. The mind usually remains clear to the last. Delirium is rare. Death is apt to be sudden, either from shock, asphyxia, or syncope.

Post-mortem Appearances.—There is nothing characteristic. There is usually general venous congestion of all the organs, especially the brain, lungs, and liver; there may be redness of the lining membrane of the stomach; the blood is generally fluid and dark in color; the heart may continue beating for a little while after death, indicating that this was caused by asphyxia. In other cases the death may be ascribed to syncope.

The fatal dose is undetermined in consequence of the diversity in the strength of the different preparations of the drug. An excise officer in England died in a few hours after merely tasting Fleming's strong tincture. Pereira speaks of a case in which two doses of six drops each of the tincture of the root, taken at an interval of two hours, produced most alarming symptoms in a young man; and Wormley alludes to an instance in which five drops of Thayer's fluid extract of the root produced most serious effects, which continued for two hours.

The symptoms may come on almost immediately or be delayed for an hour or two. Death generally occurs within three or four hours; but it may be deferred, as in other poisons, for twenty-four hours.

Aconitin.—The active alkaloid principle, abounding most in the root, of which it constitutes about one-tenth to one-fifth of one per cent. It is one of the most powerful poisons known. Pereira states that one-fiftieth of a grain nearly proved fatal to an elderly lady. Much of the aconitin as sold in the shops is totally inert and worthless. This poison has lately been brought prominently into notice in the case of Dr. Lamson, who used it in destroying his brother-in-law in England some years ago.

Treatment.—There is no active direct antidote. The stomach should be immediately emptied by the stomach-pump or an active emetic. Animal charcoal is recommended by Headland; also tannin or astringent infusions. Slight galvanic shocks are recommended to be passed through the heart, in order to arouse its action; also the employment of artificial respiration. Possibly the inhalation of oxygen might be of some advantage.

As strychnin and aconitin seem to have some antagonistic action, it might be well to employ the former cautiously in the treatment of poisoning by the latter. A case has been reported in which the recovery of a child was apparently due to two doses of tincture of nux vomica, administered twenty minutes apart.

It appears that digitalis may possess an antidotal power over aconitin. Fothergill discovered that digitalis, administered to frogs that were under the influence of aconite, relieved the heart from the depression produced by the latter poison, recalling its normal movements. A case is reported in which recovery took place in a man who, when intoxicated, had swallowed an ounce of Fleming's tincture. The patient was apparently dying, when twenty minims of tincture of digitalis were injected subcutaneously, and after twenty minutes the patient had recovered sufficiently to swallow, when a fluid drachm of the tincture was given, along with brandy and ammonium hydroxid, and was twice repeated within an hour. The above statement suggests the cautious employment of this remedy in a case of aconite poisoning.

Analytic Methods.—Aconitin, when pure, is in colorless, transparent crystals, but as found in the shops it is usually an amorphous powder, Many samples are inert. The

taste is at first acrid, soon followed by tingling and numbness of the lips and tongue. Its solution, applied to the skin, occasions a feeling of heat and numbness. So active is this poison that, according to Stevenson, one-three-thousandth of a grain of Morson's aconitin will destroy a mouse. The one-thousandth of a grain produces tingling and numbness of the lips and tongue when applied to the tip of the latter organ; and one-hundredth of a grain, dissolved in spirit and rubbed into the skin, causes a loss of feeling lasting for some time.

It has strong basic properties, forming salts with acids, which are mostly soluble. It is very slightly soluble in water, quite soluble in alcohol and chloroform, but insoluble in ether. None of the mineral acids changes it in the cold; but warm sulphuric acid imparts to it a brown tint. There is no characteristic analytic test for it. Its presence can usually only be satisfactorily established by the physiologic test—the peculiar tingling, benumbing sensation imparted to the mouth and tongue when a minute fragment of the ultimate extract is tasted, or by a similar application to the skin, attended with similar results, together with its introduction into some small animal, hypodermically.

If the poisoning has occurred from swallowing the leaves or root of the plant, a careful microscopic inspection of the stomach and bowels, and of the matters vomited and purged, should be instituted, in order to identify their botanical characters.

Toxicologic Examination.—A modification of Stas' process should be employed, similar to that described for nicotin. Chloroform is preferable as the final solvent. The residue thus obtained should be dissolved in a few drops of pure water, slightly acidified with acetic acid and submitted to

the physiological tests above described. If these afford no satisfactory results, no mere analytic tests can be relied on; but if they give evidence of the presence of the poison, then the solution should be subjected to all the known reactions, such as picric acid, platinum chlorid, gold chlorid, and the bromin test.

CALABAR BEAN.

The *Ordeal Bean of Calabar* (*Physostigma venenosum*) is a large leguminous seed, about an inch and a half long, and of a brownish-black color. It is used by the natives of the West Coast of Africa as the ordeal test for witchcraft—the suspected person being compelled to drink a decoction of the poisonous beans. It owes its activity to the alkaloid named eserin, which resides in the cotyledons. These, when touched with nitric acid, assume an orange tint, and with ferric chlorid a brown one. The alkaloid is a colorless, crystalline solid, bitter to the taste, very slightly soluble in water; soluble in alcohol, ether, chloroform, and benzene.

Bromin in potassium bromid produces with it a red color. It gives this color with less than $\frac{1}{1000}$ of a grain. According to Dr. J. B. Edwards it reacts with sulphuric acid and potassium dichromate very much like strychnin—producing the play of colors; this, however, needs further confirmation.

The action of this poison upon the lower animals is that of a spinal depressant, causing at first tremors and then paralysis, with muscular flaccidity; contraction of the pupils; respiration slow, irregular, and stertorous; sometimes there are convulsions. The heart is found to beat for some time after death. Consciousness is preserved throughout.

The effects on man are similar to the above. They are the opposite to those produced by strychnin, which is a true spinal excitant. For this reason it has been employed as a remedy for tetanus, and also as an antidote for strychnin.

Its most characteristic physiological action is the property of contracting the pupil, which at once distinguishes it from belladonna, as also from conin and curarin, which it resembles in some particulars.

The true physiological antidote is atropin, used hypodermically, and repeated until expansion of the pupil is manifested. From the experiments of Dr. Fraser and others there can be no doubt of the mutual antagonism of atropin and eserin.

The most satisfactory test is the physiological one—its power to contract the pupil. A drop or two of the suspected fluid is put into the eye of a rabbit or other small animal, and in the course of fifteen or twenty minutes the characteristic impression will be observed.

Dragendorff has succeeded in separating it from the tissues by a modification of Stas' process, employing benzene instead of ether as the ultimate solvent.

A boy, aged six years, died from eating six of the beans.

Another subdivision of Cerebro-spinants comprises those Neurotics which destroy life by asthenia, or failure of the heart's action. It is not intended to assert that they may not prove fatal in some cases in another manner, as, *e. g.*, through shock or asphyxia. But as the most strongly-marked symptoms are those of heart failure, this name answers sufficiently well for grouping together those neurotic poisons that especially display this property. The

two most important members of this group are Hydrocyanic Acid and Digitalis. For convenience Cocculus Indicus is considered under the same head.

HYDROCYANIC ACID.

Hydrocyanic Acid (Hydrogen Cyanid, Prussic Acid) is one of the most energetic and rapidly fatal poisons known. It may be obtained from many plants of the order *Rosaceæ*, such as bitter almonds, kernels of the peach, apricot, plum, and cherry, pips of apples, and the flowers and leaves of the peach and cherry-laurel. From the latter a very poisonous liquid is prepared. Hydrogen cyanid does not pre-exist in these vegetable substances, but is the product of the reaction, in the presence of water, of an unorganized ferment upon complex introgenous bodies. In the most familiar instance, that of the bitter almond, the result is due to the action of a ferment called synaptase upon a body called amygdalin. The process is quite analogous to ordinary digestion. Under the influence of the ferment, water is taken up by the amygdalin, which then decomposes into glucose, benzaldehyde, and hydrogen cyanid.

Hydrogen cyanid is a colorless, limpid liquid, extremely volatile, and having the odor recalling that of bitter almonds. A single drop placed upon the tongue of a large dog has caused death in a few seconds. The pure acid is rarely met with except in the laboratory. The dilute or medicinal acid is frequently the cause of death. This latter is merely a solution of the pure acid in water, and occurs in the shops under two different forms: (1) The official acid, of the average strength of two per cent.; and (2) Scheele's acid, of the average strength of five per cent. The strength of

both varieties varies considerably, and it is not uncommon to find some specimens totally inert, probably from the liability of the acid to undergo decomposition when exposed to the light. The dilute acid is colorless, and has the odor of bitter almonds, and a hot, pungent taste. The French acid has a strength of ten per cent.

Symptoms.—These vary with the size of the dose. A large dose—half an ounce to an ounce of the diluted acid—may produce symptoms in the act of swallowing, or in a few seconds after. They are seldom delayed beyond one or two minutes. Tardieu describes them as "coming with lightning-like rapidity." There is an immediate loss of muscular power with giddiness; the person staggers and falls to the ground; the respiration becomes hurried and gasping; the pulse imperceptible; the eyes glassy and protruding; the pupils dilated and insensible to light; the extremities cold; and sometimes convulsions occur. Toward the last the breathing is performed convulsively, in sobs. Sometimes the bladder and rectum are evacuated involuntarily. The face is pallid; the jaws spasmodically closed; there is frothing at the mouth, occasionally bloody; often the peculiar odor of the poison can be detected in the breath; death occurs sometimes in a violent convulsion, at others it is preceded by coma, with stertorous breathing. The last symptom is of considerable importance, since it might easily lead to a mistaken diagnosis for apoplexy. In animals poisoned by this substance a peculiar cry is often heard, but this does not occur with human beings.

Fatal Period.—Death generally occurs within ten or fifteen minutes after swallowing the poison. Rarely is it protracted for half an hour. One case is recorded where an hour supervened. Insensibility is not, however, always

immediate; instances are recorded of persons, after swallowing very large and fatal doses of this poison, performing many voluntary acts, such as walking into another room, opening drawers, going down stairs, etc.

The symptoms attendant on a large but not fatal dose are confusion of head, giddiness, a sense of weight upon the brain, great muscular debility, nausea, vomiting, possibly convulsions, and oppressed breathing. Several days may elapse before complete recovery takes place.

Application to the skin, especially if abraded, may occasion fatal consequences. Christison reports a case in which the liquid, applied to a wound in the hand, caused death in one hour.

Fatal Quantity.—The minimum fatal dose for an adult may be taken to be about fifty minims of the official preparation, which is equivalent to nine-tenths of a grain of anhydrous acid. The largest dose from which a recovery has been reported was one drachm of Scheele's acid, equivalent to 2.4 grains of hydrogen cyanid. Other instances are reported of recovery after taking doses equivalent to two grains and under, in all of which prompt and vigorous measures were adopted. The inhalation of the vapor is exceedingly dangerous, and has even proved fatal.

Treatment.—So rapid are the poisonous effects on the body that there is scarcely any opportunity for the employment of remedies. The cold affusion, by dashing cold water over the face and chest, should be at once employed. This should be followed by the cautious inhalation of diluted ammonium hydroxid and chlorin, along with stimulants applied both internally and externally. As a chemical antidote, a mixture of ferrous and ferric sulphates, followed by a solution of potassium carbonate, has been proposed;

this would produce with hydrogen cyanid in the stomach Prussian blue—an inert compound. The experiment has proved successful with animals.

Post-mortem Appearances.—The face is pale or livid; the eyes often glistening and staring, with the pupils dilated; the lips blue, jaws firmly set, with, at times, a bloody froth ssuing from the mouth. The blood is of a dark-blue color and fluid. The cerebral vessels are congested. Tardieu alludes to effusions of blood and serum at the base of the brain, as an occasional occurrence, which might suggest apoplexy; this, however, is negatived by the absence of hemiplegia, and by the rapidity of the death. There is congestion of the lungs and liver; and the mucous membrane of the stomach, especially about the cardiac extremity, is apt to be much reddened.

The exhalation of the peculiar odor is one of the most important post-mortem characters. This odor is sometimes perceived even before the body is opened, in recent cases, but it is particularly noticeable in opening the abdomen and thorax, and even the brain, and especially the stomach. As the poison is very volatile, it may happen that the odor will have disappeared even in a few hours, if the body has been much exposed. There is a singular variation in this respect in different cases. Moreover, the odor may be disguised by other more powerful smells, such as tobacco, mint, etc. The mere absence of odor is, therefore, no proof of the non-existence of the poison.

Analytic Methods.—There are four recognized tests for hydrocyanic acid, which may be briefly designated as the silver, iron, sulphur, and copper tests. The first three are characteristic, and they may be applied either to the liquid or vapor.

1. *The Silver Test.*—A solution of any cyanid gives, with a solution of silver nitrate, a white crystalline precipitate, distinguishable from the white chlorid, as follows: (1) By its crystalline characters (prisms or needles); the chlorid is amorphous. (2) Its sparing solubility in ammonium hydroxid; the chlorid is very soluble. (3) The permanence of its color when exposed to the light; the chlorid becomes dark-colored. (4) Its solubility in boiling nitric acid; the chlorid is insoluble. (5) When perfectly dried, and heated in a small reduction-tube, the silver cyanid is decomposed, evolving cyanogen gas, which burns with a characteristic rosy flame. (6) By adding to the silver cyanid, hydrochloric acid and ferric sulphate, Prussian blue will be formed.

Another mode of identifying the silver cyanid, recommended by Orfila and Tardieu, is, after thoroughly washing and drying it, to introduce it into a small glass tube closed at one end, from five to seven inches long, and containing in its closed extremity a rather less quantity of pure iodin. On heating this end of the tube very gently, beautiful snow-white crystals of cyanogen iodid are deposited upon the cool portion of the tube. These crystals may be preserved indefinitely in sealed tubes; and they may be used for developing Prussian blue by dissolving them in a solution of sodium hydroxid, and adding a mixture of a ferrous and ferric salt.

The silver test is particularly delicate when applied to the vapor. For this purpose the material containing the suspected poison is put into a beaker or wide-mouthed flask, and a watch-glass containing on its concave surface a drop or two of silver nitrate solution is inverted over the mouth of the flask, which should be gently heated by im-

mersion in warm water. The vapor immediately rises, and coming in contact with the silver salt, forms a white, opaque spot of silver cyanid, which can easily be recognized by a lens and by the other tests mentioned above. If, however, the material should be in a state of putrefaction, this vapor-test cannot be applied, since the black silver sulphid resulting from the hydrogen sulphid would completely obscure the white cyanid.

The silver vapor-test is considered to be the most delicate of all the tests. It is stated that $\frac{1}{1000000}$ of a grain of the acid may thus be distinctly recognized. Guy mentions that a single apple pip, bruised and moistened with water, and placed in a watch-glass, over which was inverted another glass moistened with the silver solution, yielded twenty-two distinct reactions—each spot exhibiting, by the microscope, crystals of silver cyanid.

2. *The Iron Test.*—This consists in adding to the suspected solution a little sodium hydroxid and then a mixture of ferrous and ferric sulphates; a dirty greenish-blue precipitate is thrown down, which, on addition of a few drops of pure hydrochloric acid, becomes Prussian blue. If the amount of the poison be very minute there is no immediate precipitate, although the solution has a blue (or at first, perhaps, a green) color; but in time a blue precipitate will subside.

If the quantity is very small, it is recommended to throw the liquid upon a white paper filter after adding the hydrochloric acid; the blue deposit on the paper, after washing with very dilute acid, will show very distinctly upon the white ground; the paper when dried may be preserved for exhibition, if needed.

In manipulating with this test, caution should be used not

to employ an excess of the reagents, as this materially interferes with the success of the experiment.

The iron test may also be used as a vapor-test. Moisten the watch-glass with a drop of sodium hydroxid solution, and after exposure to the suspected vapors, add a drop or two of the mixed iron salts and develop the Prussian blue by a drop of dilute hydrochloric acid.

3. *The Sulphur Test.*—If ammonium sulphid be added to a solution of any cyanid, and gently heated to dryness, a white ammonium thiocyanate is formed; when this is touched with a drop of ferric chlorid there is instantly produced the blood-red ferric thiocyanate.

The sulphur test is best applied as a vapor-test. Moisten a watch-glass with a drop or two of ammonium sulphid and invert it over the vessel containing the substance to be tested, gently warming the latter as directed. The vapor will rise and form the ammonium thiocyanate on the glass. When this is allowed to dry by evaporation it appears as a white spot, and when it is touched with a drop of the ferric salt it immediately assumes the characteristic blood-red color. If the evaporation should not have been complete so as to thoroughly dry it, the application of the iron salt may produce a *black* stain (iron sulphid), which will obscure the result.

The sulphur test, moreover, may be applied to confirm the silver test. For this purpose the spot of silver cyanid should be moistened with a drop of ammonium sulphid, and, when thoroughly dried, touched with a drop of the iron salt. The characteristic blood-red color may be distinguished in spite of the black sulphid with which it is associated.

4. *The Copper Test.*—The liquid is first made slightly

alkaline by sodium hydroxid and a dilute solution of copper sulphate is added; a greenish-white precipitate is thrown down which becomes nearly white on the addition of a little hydrochloric acid.

This test may be used also as a vapor test. The watch-glass is moistened with a drop of the copper solution made slightly alkaline, and, after exposure, a drop of dilute hydrochloric acid is added.

As regards the relative delicacy of the above tests, experiments show that for the liquid, the iron and sulphur tests exceed the silver test; but when in the form of vapor, the latter far surpasses all the others.

Toxicologic Examination.—The stomach, together with its contents, and other viscera (having first been carefully examined for the peculiar odor) should be distilled in a glass retort, at a moderate temperature, care being first taken to ascertain if the material is acid or alkaline. Unless distinctly alkaline, no acid must be added, otherwise it will be impossible to determine whether the hydrogen cyanid found in the distillate was originally present in the free state, or whether it might not have resulted from the action of the acid used upon a cyanid, a ferrocyanid, or a thiocyanate that might have been present in the material. Of course, if potassium cyanid has been the poison employed, the contents of the stomach would give an alkaline reaction, in which case the addition of sulphuric, or some other acid, would be perfectly proper. A thiocyanate exists in the saliva.

In the case of Dr. Paul Schœppe, at Carlisle, Pa., in 1868 and 1872, this point was brought out. The allegation at first was that the deceased (a woman aged fifty-four) had been poisoned by hydrogen cyanid. It was afterward con-

tended, on the failure to establish this, that the death was due to a mixture of that and morphin. The analyst employed the distillation process, along with sulphuric acid, and testified to his having only obtained faint traces of a cyanid. It was very justly contended that these "traces" of the poison could readily be accounted for by the faulty process employed in the analysis; that it might be, in fact, the result of the action of the acid upon the thiocyanate of the saliva. Moreover, there was an entire absence of the characteristic symptoms of the alleged poison before death. At the second trial, the evidence of the prosecution completely broke down, and the prisoner was acquitted.

The source of the poison found in the distillate, when an acid is employed, may be determined by treating a portion of the original material with a few drops of hydrochloric acid, stirring the mixture for a short time, and adding ferric chlorid. If the liquid contains either a ferrocyanid or a thiocyanate, the former will be indicated by the formation of Prussian blue, and the latter by the red ferric thiocyanate; whereas, a cyanid, such as potassium cyanid, will not give any reaction under the circumstances.

As regards the question whether prussic acid can be generated by the distillation of putrescent animal matters, although Orfila appears to have inclined to this belief, it is not held by later authorities. Still, something more should be insisted on as *proof* of poisoning than the finding of "mere traces," since these might possibly be the result of some animal decomposition, brought about under conditions not yet perfectly understood. Especially should this be insisted on when the symptoms preceding death did not agree with those characteristics of the alleged poison.

Period after Death when the Poison may be found.—On account of its volatility and ready decomposition all traces of the poison may disappear very shortly after death. Skillful analysts have failed to discover it in twenty-six hours after death, in some cases; while in others it has been detected as late as twenty-three days after.

The mere fact of putrefaction is no obstacle to its detection, although in such a case it will not be discoverable either by distillation or by the vapor tests. It may have all been converted into ammonium thiocyanate by the ammonium sulphid resulting from the putrefaction. In such a case the material should be rendered slightly alkaline, and then acted on by alcohol, which dissolves the thiocyanate; filter and evaporate to dryness; dissolve the residue in water, and test by a ferric salt.

Potassium Cyanid.—This salt is very much employed in photography and electrotyping, and is a frequent source of poisoning to artisans engaged in the above employments. It is a powerful poison, causing death in doses under five grains.

It is a white deliquescent solid, very soluble in water, less so in alcohol, the solution giving off the odor of hydrogen cyanid; it has an alkaline reaction.

The *symptoms*, *post-mortem lesions*, and *treatment* are similar to those described under hydrogen cyanid.

Analytic Methods.—1. It is decomposed by acids, hydrogen cyanid being liberated, which is readily recognized. 2. It gives with silver nitrate silver cyanid. 3. The potassium is precipitated by tartaric acid and platinum chlorid. 4. The iron and copper tests may be used, without the sodium hydroxid.

Organic mixtures should be rendered feebly acid with sulphuric acid and distilled. Hydrogen cyanid will be obtained in the distillate, and may be tested as indicated above. The caution as to the faint reactions due to cyanogen compounds normally present or not poisonous applies here also.

Oil of Bitter Almonds.—This does not preëxist in the bitter almond, but results from the reaction of water upon its amygdalin and synaptase. It is obtained by distillation of bitter almonds reduced to a pulp along with water. It contains a variable proportion of hydrogen cyanid and benzaldehyde. When entirely freed from the former, the oil is not a poison.

Properties.—It has a light yellow color, pungent odor, and a bitter, aromatic taste. It is heavier than water, in which it is but slightly soluble; soluble in alcohol and ether. It is highly poisonous. The liquid sold as essence of bitter almonds is a solution of this oil in alcohol; it is a very dangerous substance for domestic use.

The *symptoms*, *post-mortem lesions*, and *treatment* are the same as those described under the head of hydrocyanic acid. The fatal dose is about twenty drops.

Cherry-Laurel Water, obtained by distilling a maceration of the leaves of the cherry-laurel (*Prunus laurocerasus*), contains a portion of an essential oil similar to the oil of bitter almonds. It owes its poisonous properties to the hydrogen cyanid. Cherry-laurel water has occasionally proved fatal. It is especially identified with the case of Donallen, who poisoned his brother-in-law, Sir Theodosius Broughton, in 1782.

The seeds of the peach, apricot, and cherry, when swal-

lowed, have proved poisonous, especially to children. The symptoms are very similar to those produced by a moderate dose of hydrogen cyanid.

Nitrobenzene, or **Oil of Mirbane.**—This substance is the product of the action of nitric acid on benzene. It is a pale yellow liquid, with a strong odor of bitter almonds. It is used in perfumery and confectionery as a cheap substitute for the oil of bitter almonds. It is a powerful narcotic, producing effects resembling those of hydrogen cyanid, although much slower in its operation, requiring four or five hours before death occurs, which is usually preceded by coma, as in apoplexy. This poison operates more rapidly and powerfully when inhaled in the form of vapor.

In a fatal case it may generally be identified by its strong odor.

Analytic Methods.—It is distinguished from the oil of bitter almonds, which it so closely resembles in smell, by pouring a few drops of each upon a plate and adding a drop of strong sulphuric acid; the oil of bitter almonds acquires a rich crimson color, with a yellow border, while the nitrobenzene is not affected.

It gives none of the reactions of hydrogen cyanid.

When associated with organic substances, as the stomach, etc., it may be separated by first adding sulphuric acid and distilling.

If nitrobenzene be dissolved in alcohol and heated with hydrochloric acid and granulated zinc for some time, anilin will be formed. If the solution be filtered through a filter wetted with a solution of sodium hydroxid, the filtrate nearly neutralized with the same substance, and a dilute solution of chlorated soda, or bleaching powder, be added,

any anilin present will produce a violet color. The test is delicate, but requires careful manipulation.

Anilin, which is a derivative of nitrobenzene, has decidedly poisonous properties. Persons engaged in its manufacture or use are subject to giddiness and headache, and frequently exhibit a cyanosed condition of the face and lips. Epileptiform convulsions and insensibility also occur in the more serious cases. Acute poisoning in the human subject is almost unknown. In animals the principal symptom is loss of muscular power and coördination. There is no specific antidote. Anilin can be recognized by the production of a violet color with chlorated soda solution, as noted under nitrobenzene, the preliminary treatment with hydrochloric acid and zinc being omitted.

Anilin Colors, under which term are also included numerous artificial colors made from coal-tar derivatives other than anilin, are, as far as known, not poisonous in the ordinary sense ; that is, do not produce distinct symptoms in moderate doses. Some of them are contaminated with poisonous accessory or by-products, such as arsenic, lead, tin, and copper. Many of the published experiments on the action of anilin colors when injected into the bodies of animals are without value, in consequence of antiseptic precautions not being observed.

Antipyrin and **Antifebrin** are the trade names of two derivatives of two coal-tar products that have of late years come largely into use in medical practice. Their action is somewhat uncertain, and cases of alarming and even fatal effects have been numerously reported. Depression, chilliness, collapse, and frequent vomiting have been noted.

Antifebrin, which is an anilin derivative, is probably the most dangerous. Many of the proprietary headache cures contain one or the other of these bodies. There are no special antidotes to them.

DIGITALIS.

The purple **Foxglove** (*Digitalis purpurea*) is a native of Europe, but cultivated in our gardens. All parts of the plant contain several active principles, of which the most important are digitalin, digitoxin, digitonin, and digitalein. These are glucosids, not alkaloids.

The chief poisonous principles are digitalin and digitoxin, which always accompany each other in the plant.

Symptoms.—Cases of digitalis poisoning are comparatively rare. Until recently, its action was generally regarded as a direct cardiac depressant, reducing both the force and frequency of the heart's action. Therapeutists are now disposed to consider it as a direct heart stimulant, asserting that while the pulsations of the heart are diminished in frequency they are increased in power.

The poisonous impressions on man are nausea and vomiting, purging, with severe abdominal pains, a sense of heat in the head, vertigo, disordered vision, and dilated pupils; the pulse full and slow in the horizontal position, but rapid and feeble on sitting up. Prostration then comes on, with a tendency to syncope; the eyes very prominent and fixed, the sclerotic coat acquiring, according to Tardieu, a peculiar, characteristic blue color. Sometimes there is salivation and suppression of urine; delirium, stupor, and convulsions are apt to come on just before death, which does not, as a rule, occur within twenty-four hours. Tardieu

mentions a case in which death took place in three-quarters of an hour after swallowing, by mistake, a very large dose.

Digitalis seems to have a tendency to break out with violence after taking a number of moderate doses. The diagnostic sign of the action of digitalis is the peculiar enfeebled, intermittent pulse, which varies so notably between the supine and the erect position of the patient.

Post-mortem Appearances.—Nothing very characteristic is observed. Turgescence of the vessels at the base of the brain, together with redness of the lining membrane of the stomach, has been noted.

Fatal Dose.—This is not accurately settled. As much as a drachm of the powder, and half a fluid ounce of the tincture have been taken with impunity; but a far less quantity has produced decided effects on the heart's action. The usual dose is one to two grains of the powder, and ten drops of the tincture, to be repeated.

Digitalin.—This generally occurs as an amorphous powder of a pale yellowish color; but when pure, in fine white crystals. There seems to be much diversity of opinion concerning the percentage of digitalin in the leaves, some authorities giving it at about ten per cent., whilst Blaquart asserts that there are ten to twelve per cent. of the crystallizable variety.

There seems to be a true antagonism between digitalin and aconitin. It is stated that when the heart of the frog has almost ceased to beat under the influence of digitalin, its movements are restored by aconitin; and a case is reported of recovery after the ingestion of an ounce of Fleming's tincture of aconite, apparently due to the hypodermic injection of twenty minims of tincture of digitalis,

and the exhibition by the mouth of three doses of one drachm each, within an hour, together with brandy and ammonium hydroxid.

Analytic Methods.—Both the amorphous and crystalline varieties have a very bitter taste ; very sparingly soluble in water, also in pure ether, but very soluble in ether containing alcohol. Chloroform is its best solvent. It has no alkaline reaction. Cold sulphuric acid imparts to it a brownish color, which gradually changes to a red. If warmed, the color passes to a brown. If to the cold brown solution an excess of water be added, the color changes to a green, depositing a green powder, and the liquid gradually assumes a yellowish tint (Tardieu). Strong nitric acid dissolves it with effervescence, giving off red fumes, and imparting an orange-red color, which gradually becomes fainter. Hydrochloric acid imparts to it a light-greenish tint. It is stated that if the brown sulphuric acid solution be exposed to bromin vapor it assumes a violet hue, but Tardieu denies that this test is at all characteristic.

Toxicologic Examination.—In a suspected case the examiner should first carefully search for fragments of the powdered leaves in the matters vomited and in the alimentary canal. If the tincture has been swallowed, the interior of the stomach might present a greenish color and emit a suggestive odor. If digitalin granules have been taken, a careful post-mortem inspection might possibly reveal the presence of some of them remaining in the stomach.

The viscera, properly comminuted, should first be heated on a water bath with strong alcohol for a considerable time. After cooling and straining and proper concentration by evaporation, part of the extract may be used as a trial test on a small animal. The rest of it should be further puri-

fied by another solution in alcohol, filtration and evaporation, and the physiologic test again repeated.

It is impossible to determine positively the existence of the poison by any chemical tests, nor by the post-mortem lesions; our reliance must be solely on the physiologic test—injecting hypodermically some of the ultimate extract into a small animal, as the frog. It seems well established by numerous experiments that death takes place by a sudden cessation of the heart's action, with a decided rigidity of the ventricles at the moment of death. In frogs this stoppage occurs always in the state of strong systole of the ventricle.

By observing, then, the action of the suspected poison introduced under the skin of the frog, the gradual irregularity and slowness of the heart-beats, together with the manner of its final stop, and experimenting at the same time with digitalin itself upon another animal, we may be able to arrive at a satisfactory conclusion.

The most noted, if not the only instance, of homicidal poisoning by digitalin is that of de la Pomerais, a homeopathic practitioner of France, who was tried and convicted for killing his mistress after having insured her life in various offices for his own benefit. After one of his visits to her she died, after suffering from violent vomiting and great depression of the heart's action and debility, in twenty-four hours. Her body was examined thirteen days after death, suspicion having been aroused against the prisoner. The examiners, Tardieu and Roussin, failing to discover any poison by chemical research, resorted to the above-mentioned physiologic test, employing the extract obtained from the stomach and bowels and also one procured from the scrapings of the floor on which the deceased had vom-

ited, both of which responded likewise to all the known chemical reactions. A strong circumstantial evidence of the guilt of the accused was the finding in his possession of an unusually large amount of digitalin, a substance that had only lately been discovered, besides a number of other deadly poisons. He was condemned and executed.

Poisoning by Cocculus Indicus.—Cocculus Indicus (*Levant nut*) is the fruit of the *Menispermum cocculus*, a tree growing in the East Indies. The kernel of the berry is the only poisonous part. It has an intensely bitter taste, and contains a highly poisonous principle called picrotoxin. It is chiefly employed as a fish poison and sometimes for the malicious destruction of game. It is popularly believed to be used for adulterating malt liquors, by imparting to them a bitter flavor and increased intoxicating powers, but this must be unusual. It is also used for the destruction of vermin.

The symptoms are somewhat singular, indicating an action on the cerebro-spinal centers. There is loss of voluntary power, but not of consciousness, the sufferer lying in a sort of nightmare. There may also be nausea, vomiting and severe abdominal pains. Dr. Fish reported cases of accidental poisoning of six persons in the Philadelphia Hospital by a decoction of this substance. Two of these died in about half an hour; the remaining four were seized with violent symptoms within half an hour after swallowing the poison, and recovered after several hours. Their symptoms were faintness, confusion of mind, giddiness, dimness of vision, nausea, excessive thirst, severe abdominal pain, and, in one case, insensibility; the pulse was much weakened and the respiration slow and labored.

The external application has been followed by violent and even fatal effects.

Picrotoxin constitutes about one per cent. of the kernel. It crystallizes in colorless, silken, slender, four-sided prisms; sparingly soluble in water, very soluble in alcohol, ether, chloroform, and amylic alcohol. Cold sulphuric acid does not affect it; the hot acid imparts to it an orange-yellow color, which becomes pale on cooling. Strong nitric acid and hydrochloric acid do not affect it. It acts like grape sugar when boiled with copper sulphate and sodium hydroxid.

It may be separated from organic liquids by first acidulating with hydrochloric acid and then shaking up with ether, which holds the poison in solution and deposits it in crystals.

There are several other vegetable poisons of minor importance; among them may be mentioned the bark and seeds of the Laburnum (*Cytisus laburnum*), a very common tree or shrub of Great Britain. It contains an active poisonous alkaline principle, cytisin, whose effects are those of an irritant narcotic. Death has frequently resulted from swallowing both the bark and seeds of this plant.

The leaves and berries of the Yew (*Taxus baccata*) act powerfully as an acrid, irritant narcotic, even in small quantities. They owe their poisonous properties to an alkaloidal principle which destroys life by paralyzing the respiratory centre.

The Privet (*Ligistrum vulgare*); the Guelder Rose (*Viburnum opulus*); and the Holly (*Ilex aquifolium*) also possess poisonous properties.

PTOMAÏNS.

Within the past few years the attention of toxicologists has been called to the existence of a certain class of bodies, to which Selmi gave the name of *Ptomaïns* (from πτῶμα, *a dead body*), resulting from the decay of organic substances. These bodies strongly resemble the alkaloids in their chemic and physiologic actions. Whilst some of them are very poisonous the majority are inert, and others again seem to be antagonistic to certain poisons.

It has long been known that putrescent meat will occasion severe and sometimes fatal symptoms in persons who partake of it. These symptoms are of a narcoto-irritant character and strongly resemble those produced by certain familiar poisons. Similar effects are also known to occasionally result from cheese, sausages, and certain shell-fish, particularly from mussels; and, in some instances, from canned meat and vegetables. These anomalous symptoms have formerly been attributed to various causes, but hitherto no satisfactory explanation of them has ever been offered until the discovery of the ptomaïns has solved the mystery and afforded a rational and scientific solution.

It is now known that putrefaction is due to the presence of microbes, which, when introduced into the animal body, may speedily develop serious and even fatal disease. This fact affords a satisfactory explanation of those otherwise obscure cases of poisoning that occasionally result from partaking of certain articles of food, such as canned provisions, milk, ice-cream, sausage, cheese, etc., which have undergone unsuspected putrefaction.

Many ptomaïns have been isolated, and the discovery has opened a new field of investigation in physiologic chemistry.

Some ptomaïns bear a strong resemblance to some of the vegetable alkaloids in both chemical and physiologic reactions; and as they may generate by putrefaction in the human viscera, it may readily happen to the analyst to encounter one of these ptomaïns in searching for strychnin, morphin, nicotin, etc., in a putrescent human body. Fortunately the ptomaïns occurring under the above conditions are not always met with; moreover, the expert, with proper precaution, will be able to discriminate between them and the true alkaloids from the fact that, although they have many points in common, there exists reactions, both chemic and physiologic, in which they differ.

A few of these ptomaïns may be mentioned: A *strychnin-like* substance has been discovered, which is highly poisonous, and which responds in an imperfect manner to the color-test and also to the test with iodin, but lacks the pronounced bitter taste of strychnin. A similar ptomaïn has been discovered, in Italy, in decomposing maize, capable of exciting tetanic spasms when injected into an animal; but differing from strychnin in not being extracted with ether.

Atropin-like Bodies.—Several investigators have found products of putrefaction resembling atropin and hyoscyamin in their mydriatic properties; also in their chemical reaction with platinum chlorid.

A *veratrin-like* ptomaïn has been extracted from a putrefied human body, which gives the peculiar test of that alkaloid when heated with sulphuric acid; but it differs from veratrin in reducing ferric salt instantly, and in its want of action upon frogs.

Conin-like substances have been procured by different chemists; they are oily, alkaline, and volatile bodies, very bitter to the taste, and highly poisonous. The odor is

strong and unpleasant, but different from that of conin, though some of the chemical reactions resemble those of this alkaloid. Selmi subsequently obtained a ptomaïn from the viscera of bodies buried six to ten months, which yielded the unmistakable mousy odor of conin.

A *nicotin-like* ptomaïn has been procured from a putrescent body, which was strongly alkaline, oily, and volatile, and possessing a powerful odor, but differing from nicotin in several of its chemical reactions.

Numerous other ptomaïns have been isolated from the putrescent viscera of the human body, some of which are highly poisonous, while others are innocuous. They possess comparatively few features in common with the vegetable alkaloids.

One of the most interesting and important ptomaïns is that discovered by Vaughan in cheese and milk, and subsequently found in ice-cream and cream puffs. It was named *tyrotoxicon* by the discoverer, but he has since shown that it is diazobenzene. It is a powerful poison.

Another point in this connection that should not be overlooked by the toxicologist is the fact that the presence of one or more of these ptomaïns, along with certain of the vegetable alkaloids, in a dead body may interfere with the usual chemical tests employed for the detection of the latter poison. This is true, to some extent, in the case of strychnin, brucin, atropin, aconitin, picrotoxin, and a few others; but this subject has not received sufficiently full attention to enable us to speak very positively about it. Ranke contends that the proper physiologic action of the impure strychnin extracted from a putrefied body may be masked by ptomaïns. If this observation, as also those above mentioned, is correct, it may explain the occasional failure to

discover strychnin and other alkaloids in a putrescent body.

Selmi and others have succeeded in extracting poisonous bases from the urine of patients suffering from tetanus, progressive paralysis, and miliary fever ; one of these resembled nicotin in its general character, showing a special tendency to act upon the spinal marrow and heart ; the other base resembled conin in odor.

Still later researches go to prove that animal fluids, such as fresh blood and albumin, before undergoing putrefaction, give precisely similar reactions, with the reagents employed, to those that are afforded by these same reagents with ptomaïns extracted from a dead animal body.

It will be inferred from all that has been stated upon this subject that the whole matter concerning ptomaïns may be regarded as being, to a considerable extent, still *sub judice* ; and the existence of these cadaveric alkaloids in human viscera, even when putrid, is probably not of such frequent occurrence as was suspected. Nevertheless, it cannot be doubted that their alleged existence will be constantly brought out in trials. Such a course is stated to have been taken at the Lamson trial, in London, in 1883. On the other hand, it might be speciously argued that the reason for the non-discovery of the alleged alkaloid was to be attributed to the interfering presence of some ptomaïn.

Much light has been thrown upon the relations of the ptomaïns in toxicologic chemistry by the investigations of Vaughan. Ordinary putrefactions are aërobic—that is, take place under the influence of free oxygen. Laboratory studies of decompositions, either in culture fluids or in ordinary foods, have been, therefore, largely limited to one class of actions—those of microbes which grow in the

presence of oxygen. It is now known, however, that not only are there several species of microbes which grow only in the absence of oxygen, but some of those ordinarily growing in contact with oxygen can grow in its absence, producing substances different from those formed under normal growth. In buried corpses the decompositions will be at low temperatures, and with at least very deficient oxygen supply; hence the transformations occurring in the viscera will not be identical with those when the body lies unburied or submerged in water. Vaughan has shown that it is in this anaërobic decomposition that ptomaïns simulating the vegetable poisons are likely to be formed. In a recent trial it was claimed by Vaughan and others that an organic product of animal putrefaction, commonly called indol (but properly indin), gives color-reactions simulating some of those of morphin. It seems, however, that the probability of error from this cause has been overrated, and in general it may be said that, with careful routine work, there is no great danger of ptomaïns being mistaken for the well-known alkaloid poisons. Much more extended investigation will be needed to give precision in this field.

NOTE ON THE DETECTION OF CARBON MONOXID.

The following data were accidentally overlooked when the subject of carbon monoxid poisoning was under consideration:

Rubner states that if blood containing carboxy-hemoglobin is shaken vigorously with about five times its volume of solution of lead acetate it becomes bright red, while normal blood becomes brown. The difference of color increases on standing. The color persisted in open

tubes for three weeks. The test will show comparatively small amounts of carbon monoxid.

It has been stated (" Med. Rec.," Sept. 11, 1897) that in death from carbon monoxid poisoning, a spot of softening is always found in the innermost part of the lenticular nucleus near the knee of the internal capsule.

INDEX.

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Gould's Dictionaries, Page 8.

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